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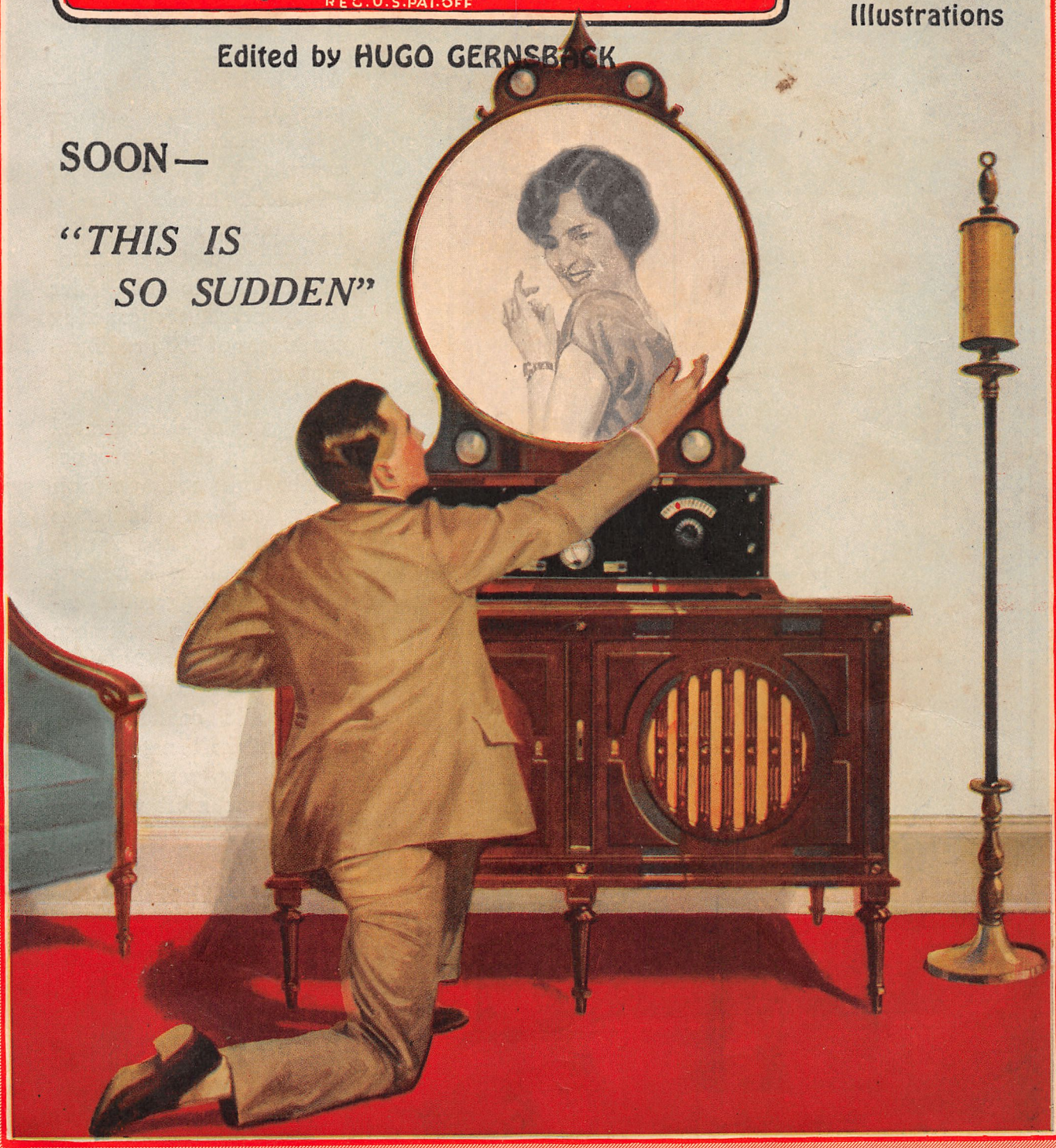

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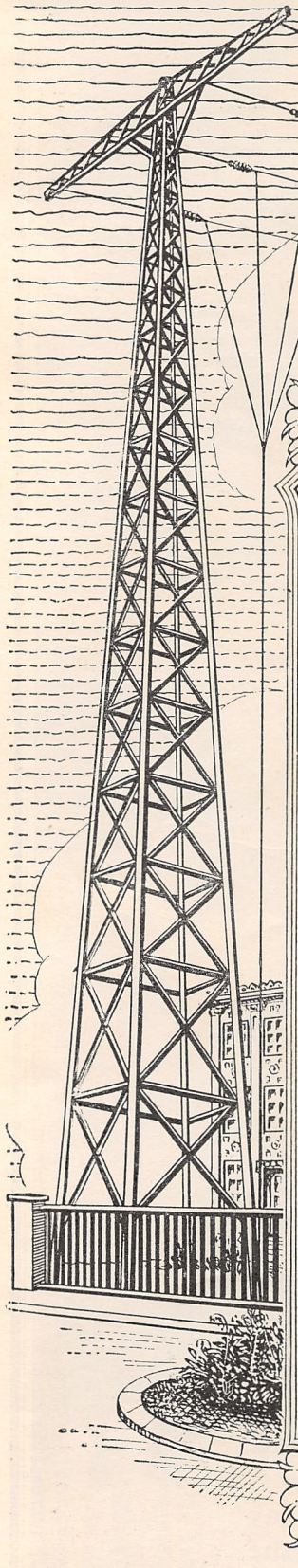

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VOLUME 7 NUMBER 11

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MAY, 1926

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All About Audio Frequency Amplifier Transformers,
By Sylvan Harris.

Our readers have learned considerable about the research work that is continually being done in RADIO NEWS laboratories; some of which was presented recently in articles on the resistance of coils. A series of articles by Sylvan Harris on audio frequency amplifier transformers in which much will be told of transformers that has generally been omitted by other writers on the subject, will appear, beginning next month.

* * *

A New Convenient Method of Assembling Radio Sets,
By Joseph Riley.

Introducing to the radio constructor a new system of building receivers, which eliminates a great part of the routine work of making connections, with superior results for less effort.

* * *

An Effective Radio Set That Is Really Portable,
By Leon L. Adelman.

This can be carried about by the owner with comparative ease; yet, light as it is, it has remarkable selectivity and good quality and volume. Excellent for the constructor.

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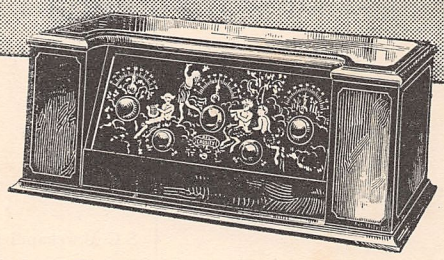

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And the RFL sets possess *true* cascade amplification. For Crosley has utilized an entirely new patented circuit which achieves cumulative amplification, actually approaching the theoretical maximum efficiency per tube.

The Crescendon

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The Crescendon is an exclusive Crosley device for increasing the weak signals of distant stations to full volume tones without distortion. Yet with these sets, loud nearby stations can always be softened practically to whispers.

Their striking beauty will please your eye, and your ear will introduce to you new qualities in radio, which you are sure to pronounce a revelation.

See the new Crosley sets at your dealers or write Dept. 22 for literature.

Crosley manufactures radio receiving sets which are licensed under Armstrong U. S. Patent No. 1,113,149, or under patent applications of Radio Frequency Laboratories, Inc.

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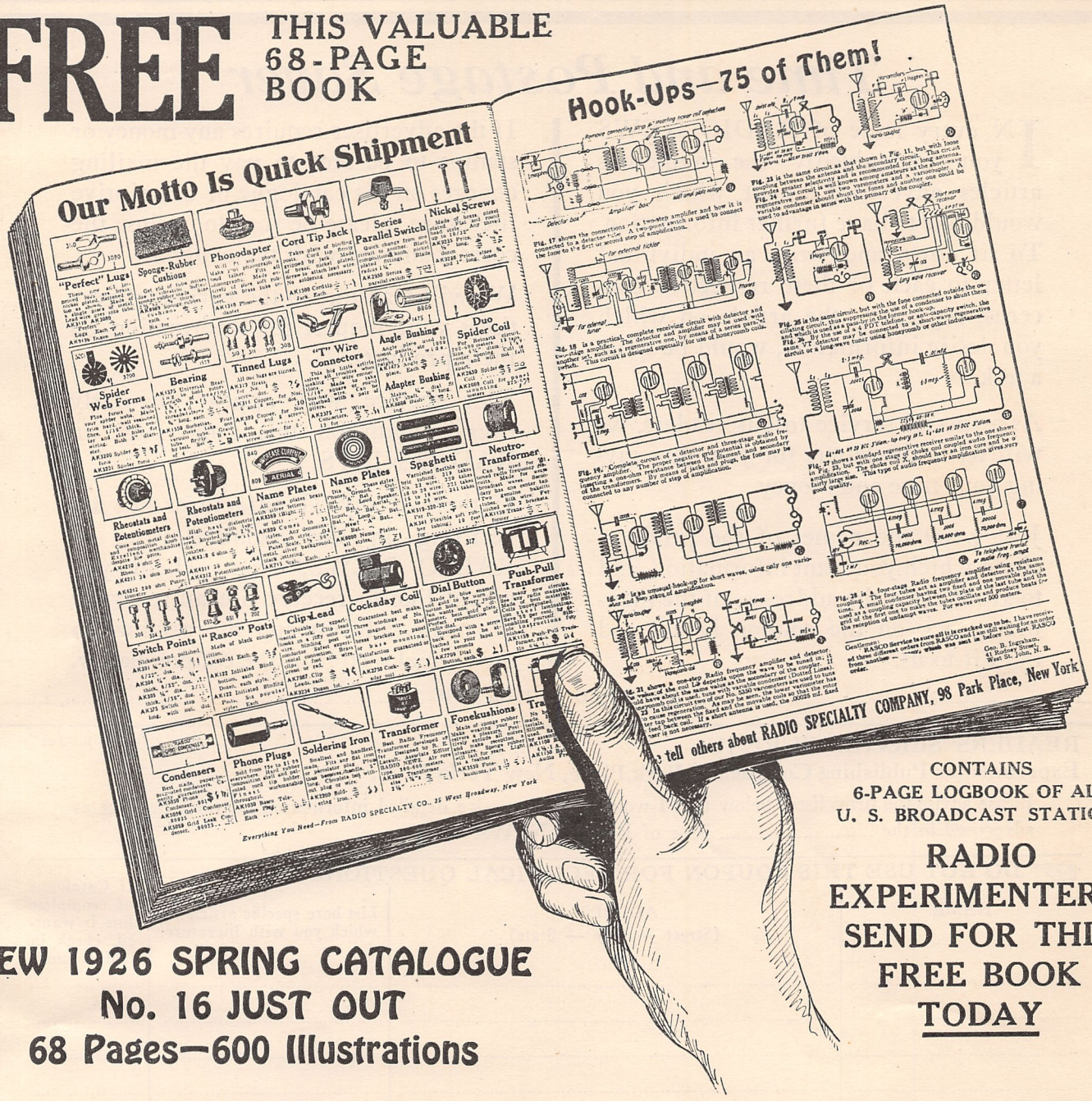
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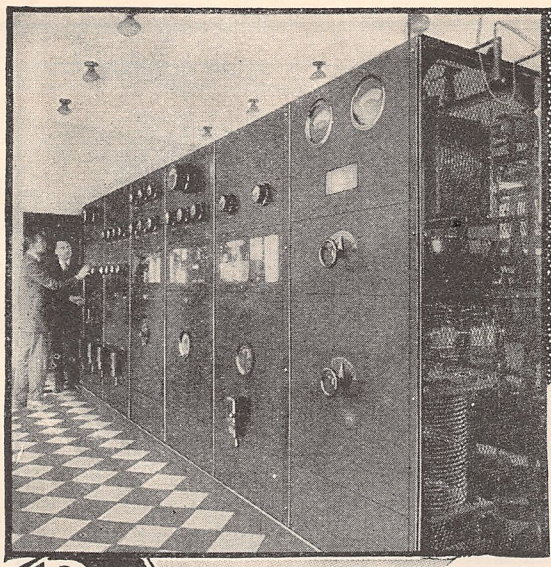

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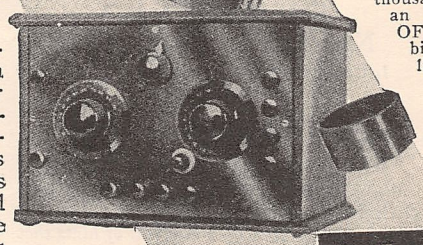

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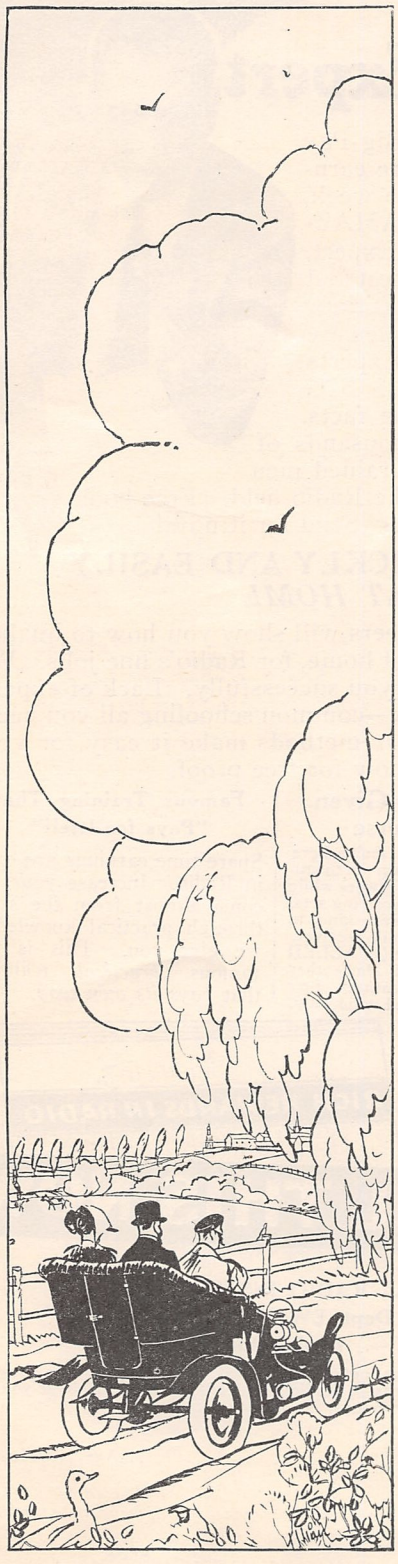

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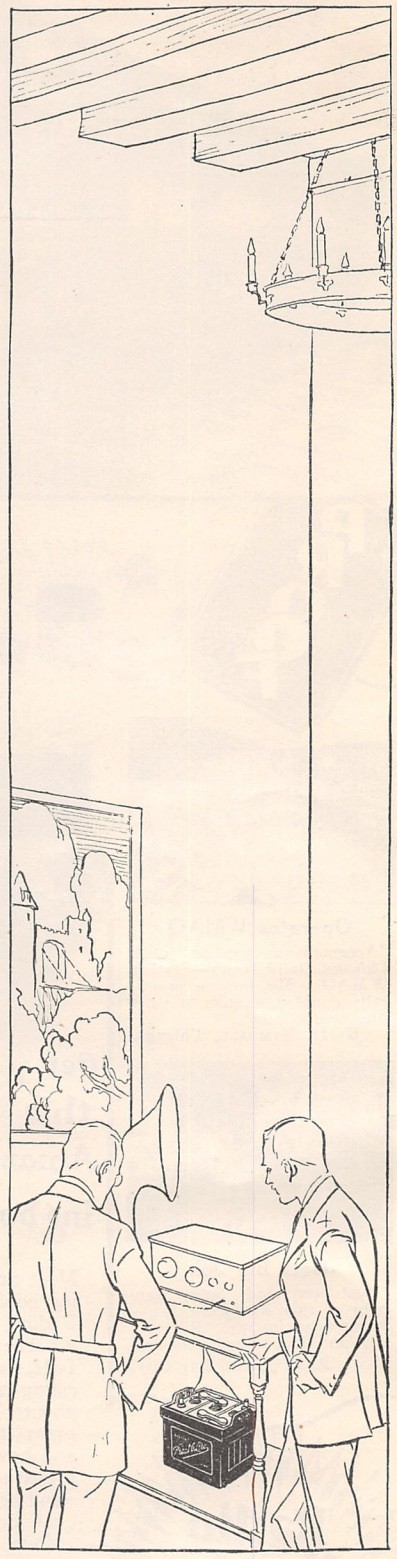

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RADIO NEWS

H. GERNSBACK, Editor and Publisher
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EDITORIAL AND GENERAL OFFICES, 53 PARK PLACE, NEW YORK

Vol. 7 MAY, 1926 No. 11

Radio Television

By HUGO GERNSBACK, F. R. S.

I AM frequently asked this question: "What, in your opinion, will be the next great development in Radio?" And to this question I always answer that, in my opinion, the next and most logical step in Radio will be the establishment of "Television," or the power to see objects at any distance, through the same medium by which we are now enabled to hear sounds by radio from all over the world.

Radio receiving sets have been developed to such a high degree that we need not expect any revolutionary improvements to be made in them for some years to come. The radio receiver is now at the stage of development such as the automobile reached ten years ago. The improvements made since then in the automobile have been only in the refinement of its various parts; and it will prove exactly so with radio.

So, when I speak of Television, I do not predict a novel type of radio set *per se*, but rather the creation of a device which can be attached to your radio set. It will be similar, in its relation to the present radio set, to the loud speaker, which can be connected to your set, regardless of whether the latter is of the vintage of 1923, or the latest 1926 model.

This may seem to be a rash, offhand statement, but a moment's consideration will show that it is not. For instance, you can listen to a full orchestra with your radio set and (providing you have good transformers and your loud speaker will take both the upper and lower ranges) you will find no trouble in distinguishing the notes of the bass drum from those of the piccolo, even though both are playing at the same time. In other words, you hear simultaneously a number of different instruments without their interfering with each other.

Through the future application of Television, it is quite logical that while a station is broadcasting a song, you will be able to see the face of the singer at the same time, through a transmission on the same wave to which you are tuned in, for the following simple reason.

The range of acoustical frequencies is really very narrow, and does not take in a wide band; the human ear responds to no vibrations above a frequency of 23,000 per second. That is the reason why the so-called radio "carrier" is inaudible. To the non-technical reader it may be explained that the "carrier" is the fundamental wave emitted by a broadcast station, which is on the air at all times when the station is transmitting. When no one is speaking or singing at the broadcast studio, you hear nothing but a faint rushing sound in your receiving instrument. The vibrations of this carrier run into millions per second, and that is why we cannot hear them directly.

If however Television is perfected (as it almost surely will be during the next two years, or perhaps sooner) it will be possible to impress the Television impulses upon this same "carrier" which brings the sound impulses to your set. The Television impulses, being of a frequency too high to be audible, will not interfere with your loud speaker; and the Television picture for the same reason, will not be mixed up with the speech, any more than a violin or a piano, both of which you can readily distinguish with your ear. This is an inadequate comparison, because the separation between the acoustical band or audio frequencies and the radio frequency band is enormously wider than that between any two audible notes of music; and it will therefore be practically impossible for the "sight" waves and sound waves to interfere with each other.

I have pointed this out to bring home the point that, when Television is finally brought about, it is quite probable that today's radio sets will be adapted to this new purpose; and that it will be possible to connect a Television attachment right to your present set and thereby see what is going on all over the country while you are enjoying the program. Not only will it be possible to see the entertainers at the broadcast station to which you tune in, but everything that is broadcast for sound only, today, will be broadcast by "remote control" for Television as well.

Radio Television, it must be said, is nearer at hand than most of us realize. The inventors of the entire world are racing frantically for the goal, because they realize that in Television they will have created a great new emancipator, much greater than the telephone or radio communication itself.

In this country C. Francis Jenkins has been in the foreground in Television experiments; and he has achieved success in making it possible to transmit and receive the outlines of moving objects by radio at the present time. In England, it is reported, John L. Baird, who has been on the same track, has accomplished a great deal; in France Professor Edouard Belin has also produced results, and similar work has been done in many other countries. Television is now "in the air," and I shall be very much surprised if this great new art does not step out of the laboratory into every-day use, sometime in the next two years, or less.

Back in 1915, and again in 1918, I wrote a series of articles on Television which were the first, I believe, published in the technical press. At that time we had only the selenium cell as a "photo-electric" or light-sensitive substance; but it is sluggish and does not follow changes of light with sufficient quickness. It has been superseded recently by some very excellent light-sensitive cells, which react to changes in less than one ten-thousandth of a second; and this improvement makes Television an assured possibility today.

We should not be surprised, also, when the final apparatus is evolved, to note with what simple instruments Television can be accomplished. It is my belief that the successful device will be simpler and of fewer parts than our radio receivers are today, and it is quite possible that within the next ten years $50 will purchase a complete Television attachment which will perform well.

To be sure, for a long time to come, transmission will be only in black and white, giving an effect similar to that seen in motion pictures now. Color transmission will come later.

At this point I desire also to correct an erroneous idea about Television, which is much in vogue now. Many people think of Television as "radio motion pictures." Of course there will be no motion picture equipment of any kind in the radio Television apparatus. Television does not concern itself with such methods at all. *In reality you will see at a distance,* just as if you had a telescope through which you could observe anything going on in any part of the country.

Television between broadcast stations and the broadcast public will become very popular. If the telephone companies wish, they can make simple attachments for the present-day telephone, so that you can see the person at the other end with whom you are conversing. A lot of people will throw up their hands in horror at this idea, because the idea of Television added to the telephone will suggest a reduction of their privacy to the minimum enjoyed by a gold fish. This need not be feared, however, because a pushbutton in the telephone mounting will insure that the party calling cannot see you unless you wish it. This is a very simple detail.

As to radio Television between private parties, such as depicted on the front cover of this magazine, I must admit that this lies much further in the future—perhaps twenty-five years or more, for there are not enough wave-bands available to make it possible for thousands to talk to each other at the same time. On the other hand, the cover illustration could readily represent two radio amateurs, who can converse by radio telephone even today; and if, in the next two years, they are enabled to place Television attachments on their radio sets, there might easily result such a situation as shown on the cover. But the individual application of Television, to every one's personal convenience, will not be practicable for many more years.

Mr. Hugo Gernsback speaks every Monday night at 9 P. M. from Station WRNY on various radio and scientific subjects.

Nature's Radio

By G. C. B. ROWE

Although a great deal is known concerning the habits of the animal and insect world, their method of communication in some cases is still a mystery. This article shows the efforts made to solve some of these problems.

ONE of the greatest of the unsolved mysteries of the world is the manner in which different animals, insects and fish communicate with each other. Scientists have been working on this problem for many years and, up to the present, the results that have been attained are disappointing. It is not desired to give the reader an impression that solutions to these problems are set forth in this article.

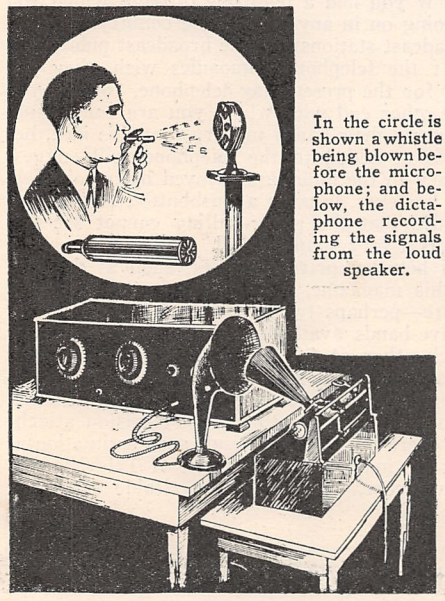
Recently, in London, some very interesting experiments were performed to see if the communication between some creatures has anything to do with radio waves. It is a well-known fact that Nature has endowed some insects with very strange transmitting and receiving sets. This does not mean the audio frequency howls which are broadcast from the lion house at the Zoo at feeding time, but some stranger and less-understood forms of radio. Some animals such as fish, snakes, birds and insects, have very peculiar ways of signalling to each other, many of which scientists do not pretend to understand.

THE AMATIVE EMPRESS

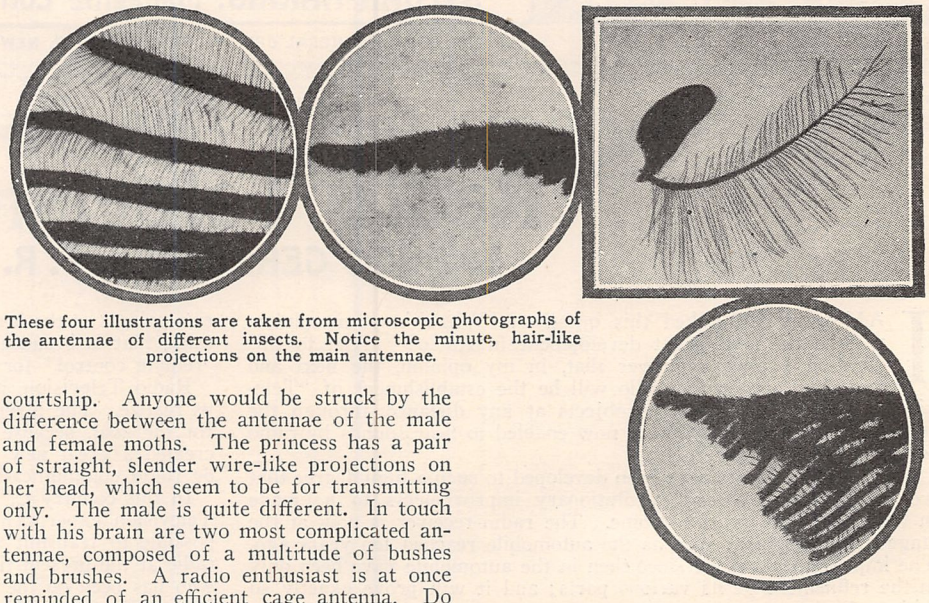
For example, let us consider the mystery of the Emperor moth. When a female emerges from the cocoon, she is never worried about a mate. At once she starts to send out some sort of mysterious waves demanding a husband. *How* she does it is one of Nature's unguessed riddles, but the effect of her signals is amazing. This Emperor moth has been the subject of an experiment which checked up with the information at hand. A newly-hatched female moth was placed in a gauze box and concealed in the pocket on an overcoat. The wearer of the coat then went for a walk in the country, and almost instantly suitors for the imprisoned lady's hand appeared from all points of the compass! In fact there were as many as eight beautiful moths crawling over the coat at once, trying to find the Sleeping Beauty—only she must have been very much awake.

Now then, how is this remarkable feat accomplished?

Some naturalists put it down to a scent of an extraordinarily penetrating character, which cannot be perceived by human sense. It may be that some form of radio, by ethereal vibrations, is involved in this strange



In the circle is shown a whistle being blown before the microphone; and below, the dictaphone recording the signals from the loud speaker.



These four illustrations are taken from microscopic photographs of the antennae of different insects. Notice the minute, hair-like projections on the main antennae.

courtship. Anyone would be struck by the difference between the antennae of the male and female moths. The princess has a pair of straight, slender wire-like projections on her head, which seem to be for transmitting only. The male is quite different. In touch with his brain are two most complicated antennae, composed of a multitude of bushes and brushes. A radio enthusiast is at once reminded of an efficient cage antenna. Do these play an important role in picking up the mating call of the female?

This riddle is hard to solve, because the senses of a man and a moth are so widely different that it may be a very long time before we can determine whether the result is due to unsmellable "scent," inaudible "sounds," or undetectable ether waves.

DIFFERING RANGES OF HEARING

These inaudible "sounds" just mentioned are quite common in Nature. The ordinary singing of a grass-hopper (called stridulation) is done by rubbing a leg against the toothed edges of the wing cases, and so causing vibrations, just as a boy draws a stick along a picket fence. There are some Indian crickets so small that this note vanishes; it gets too high in pitch for the human ear to detect. Yet you can see the little cricket sawing away for all he is worth. This is exactly what happens when a heterodyne whistle produced by two neighboring broadcast stations gets higher, and finally disappears, when they alter their wave-lengths. The whistle is still there, but we cease to detect it and so it vanishes, so far as our ears are concerned.

At the opposite end of the animal kingdom, there are the elephants. If we had the ears of these mighty monsters, we could crowd many more stations into the broadcasting wave-band, for their hearing apparatus is too coarse to perceive certain heterodynes that cause us extreme annoyance. On the other hand, if we had ears like dogs and cats, we would continue to hear noises after the sound has grown too high (not too faint) for the human ear.

Recently certain of these inaudible sounds were broadcast from station 2LO in London for the benefit of the cats and dogs of listeners, with very amusing results. Apart from the excitement and interest shown by the animals, a very interesting test was made behind the scenes of the broadcast station.

"ULTRA-AUDIBLE" SOUNDS

There was some question as to whether these inaudible sounds were actually transmitted over the air by means of the microphone and antenna. A dictaphone was placed at the mouth of a loud speaker. It was geared to run at about four times its normal rate of revolution; so if a note of 20,000 cycles per second was sent out, the dictaphone running at its normal speed would reproduce it at 5,000 vibrations per second, which is an audible frequency, within the range of the human ear.

The test consisted of blowing a particularly ear-splitting whistle of the familiar siren type, starting at a low note and gradually rising in pitch until there came a silence, and then a descending note. It was this silence in the middle of the run that was the interesting part of the question. When the dictaphone was run at the usual speed, it was found that this silent part of the whistle was made audible by the slowing up of the machine. The sound had never really vanished, and the dictaphone rendered it as an unceasing whistle which rose and fell without a break at its highest point.

This illustration of soundless noise is just to show you the possible explanation of some mysterious things in the animal world.

During the World War it was noticed that pheasants perceived the approach of aircraft long before any of the man-made listening devices. Disturbances in the coverts showed that something was worrying the birds, and then the raiders appeared to confirm their fears. This was made use of in the anti-aircraft stations by having a few pheasants in a cage and watching their behavior, telling by their actions if they heard something strange in the air. Hearing of a most exquisite acuteness seems to be the only explanation.

Matters are not quite so simple when we consider the case of sea-animals and fishes. When a conger-eel is taken out of the water he will bark. What use does he make of his voice under the surface? It is a well-known fact that water is a better transmitting medium for sound than air; so another experiment was performed to find if fishes made any audible sounds. A special microphone was placed in a tank of water in which there were a number of different types of fishes and sea animals; and through an audio frequency amplifier any sounds that were picked up were heard in a pair of headphones. However this experiment was a failure, as the only sound heard was the crunching of a small shell fish by a giant crayfish, something like a lobster.

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Radio Makes Servants Contented

By Mrs. CHRISTINE FREDERICK

One of the greatest problems faced by the housewives of America today is how to keep a servant. Mrs. Frederick has found that radio is a powerful ally and tells about its effectiveness in promoting household morale.

"I have proved that radio makes life more agreeable and their jobs more endurable for servants."

"THE servant problem" is probably as old as Methuselah. It must have annoyed Abraham and Solomon—and even the Pharaohs of Egypt, for they sought a particular kind of people for slaves!

Certainly America women—and now also European people, since the war—are finding servants not only scarce, but also less readily contented. I remember that years ago I had an Irish girl, fresh from the old country, who was so faithful to me that she even shed tears of regret when she left to be married! Today if—just for once—you don't use just the proper tone of respect a servant thinks she's entitled to, she'll tell you she's going to leave; sometimes she does it without even so much as an hour's notice—sometimes no notice at all!

The reason is, of course, that our national prosperity has been such that the servants go into better jobs. Nowadays, factories have quite remarkable facilities for the comfort and entertainment of their workers; recreation parlors, gymnasiums, dance halls, library and whatnot. They are competing with deadly success with the housewife who wants to keep a servant. What is she to do about it?

The jokes about giving the maid your purse, letting her wear your clothes, permitting her to take piano lessons and even giving her "carte blanche" with your Rolls-Royce, are not altogether unfounded. People do astonishing things these days to keep their servants happy. (A friend of mine permits her maid to represent herself as her sister; as the maid, a pretty thing, has a horror of social stigma.) The principal reason why maids leave an employer who seemed to think they ought to be happy, is insufficient thought given to the worker's psychology, and neglect of factors conducive to making the servant happy in her environment. True, it isn't possible or practicable to spend hours pondering over what will make the servants happy; but a little thought on this subject is well repaid. Frankly, women deserve some of their servant troubles because they look on their workers as machines without human feelings.

"THEM DAYS ARE GONE FOREVER!"

To begin with, the "servant" of years ago is no longer the "servant" of today. The quantities of fat "Katinkas"—competent, thoroughly illiterate, and cotton-stockinged, are gone! The immigration laws have prevented the influx, in the old large quantities, of these foreign women who plodded through their housework like chunks of animated beef. Those husky women who, when you ordered them to clean and sweep thoroughly, proceeded with muscular arms to do it with the efficiency of European housewifely standards, are rarities today! They worked far harder for less pay, far longer hours, than servants today. When they were finished with a heavy day's labor they forthwith proceeded to soak their feet in hot water because they hurt so! Fannie Hurst has adequately dramatized one of these herculean helpers of the kitchen, as "Lummox," and has proved in her book how poorly women used to treat their servants.

But today is oh, so different! If you do get a Polish or Russian maid these days, you can't be at all sure she isn't a *"declassé"* noblewoman! Perhaps all this has come out of the war; but it is a fact that the "servant," as she was before, does not now exist! She has become an entirely different person!

During the last five or six years all my cooks have been, at some prior time in their lives, (if they can be believed) married, and have had more luxurious homes than I have! One of them had a more expensive fur coat than I have! One woman, who was a housekeeper for me, was of the Spanish nobility! The nurse for my daughter was taking courses at Columbia University and studying to be a short-story writer. An "upstairs" girl, whom I had to sweep and dust, was studying to be a nurse.

So you see, the modern "servant" girl is altogether different. Many are only in domestic service for a transient period, expecting soon to go to something better.

All this being true, we must change our attitude toward the servant. We must think

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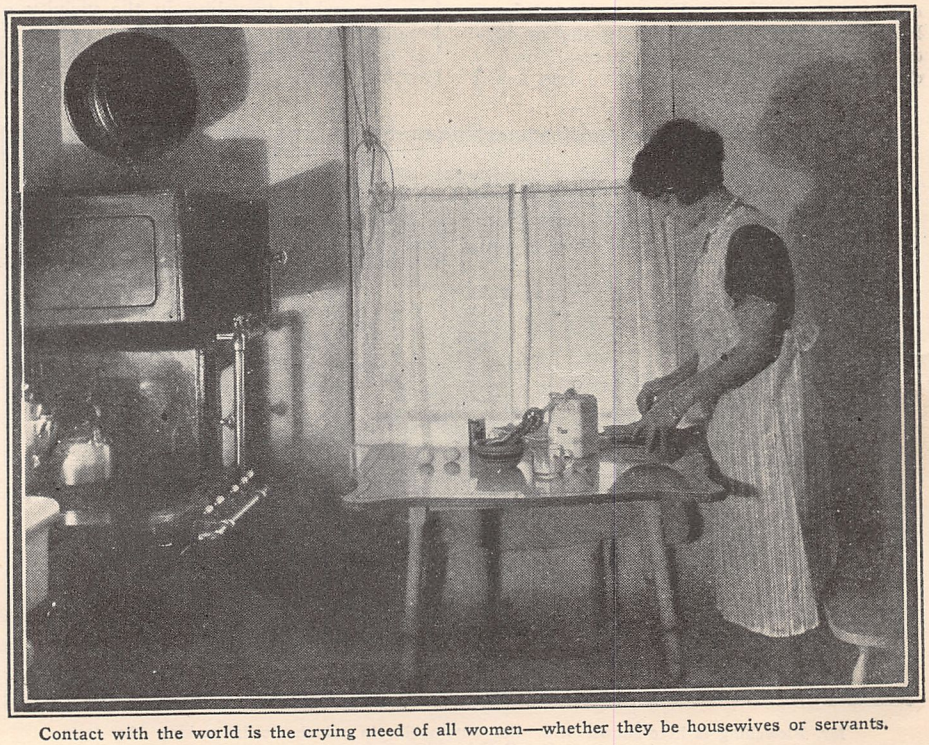


Contact with the world is the crying need of all women—whether they be housewives or servants.

EDMUND T. FLEWELLING

Your Auto and Your Radio

By EDMUND T. FLEWELLING

In this article is told how an automobile trip and a radio set were successfully combined. This is the first of a series of popular articles by Mr. Flewelling that will appear in RADIO NEWS.

THIS is about the right time of year to begin giving a thought or two to the use of a radio receiver in your old bus. Many attempts at reception of broadcast programs in an automobile have been made already, many more will be made, and finally it will become the generally-accepted thing to do.

WE take pleasure in informing our readers that we have made exclusive arrangements with Mr. E. T. Flewelling for twelve monthly articles to appear in RADIO NEWS.

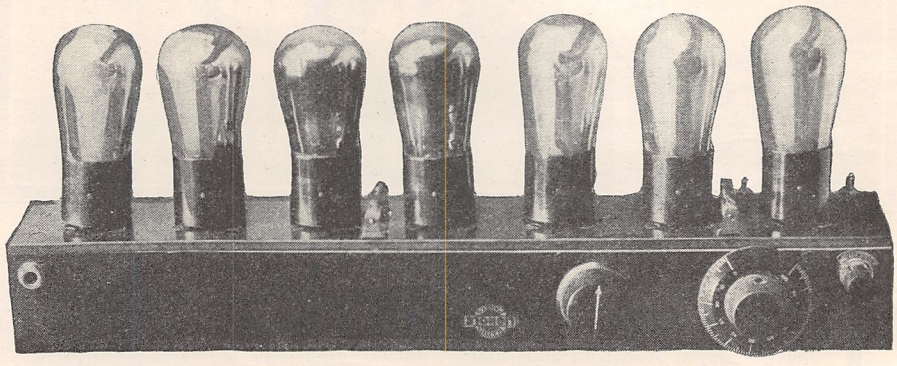
Mr. Flewelling needs no introduction to our readers. He is well known as one of the foremost radio research experimenters and author of the famous Flewelling Super-Regenerative Circuit.

Mr. Flewelling is working on a number of very important features, many of which will make history in radio. All the articles bearing on this and subsequent problems will appear exclusively in RADIO NEWS during the coming months. —Editor.

Because the writer has been running about with a car and trying this stunt for several years, until the Eastern States have been pretty well covered, thus giving an idea of actual automobile reception conditions in different localities, RADIO NEWS has asked him to tell what is experienced, what kind of set is best to use, and to give general instructions about using it.

With a three-tube regenerative receiver, operating from an open antenna strung in the top of a touring car (as diagramed) many interesting facts were observed. Such a receiver will tune very sharply, because of the small size of the antenna, and the small capacity from its ground, which is the frame of the car. Loud speaker operation may be secured without much trouble, up to fifteen miles from a 500-watt broadcast station; and up to twenty-five or thirty miles, depending on the power of the transmitter, by careful tuning.

No greater distance than this may be counted upon from such a receiver in a moving car, although frequently a station a hundred or more miles away has come in with decent volume. It is the same old story of location, power, and a thousand and one other factors affecting radio reception.



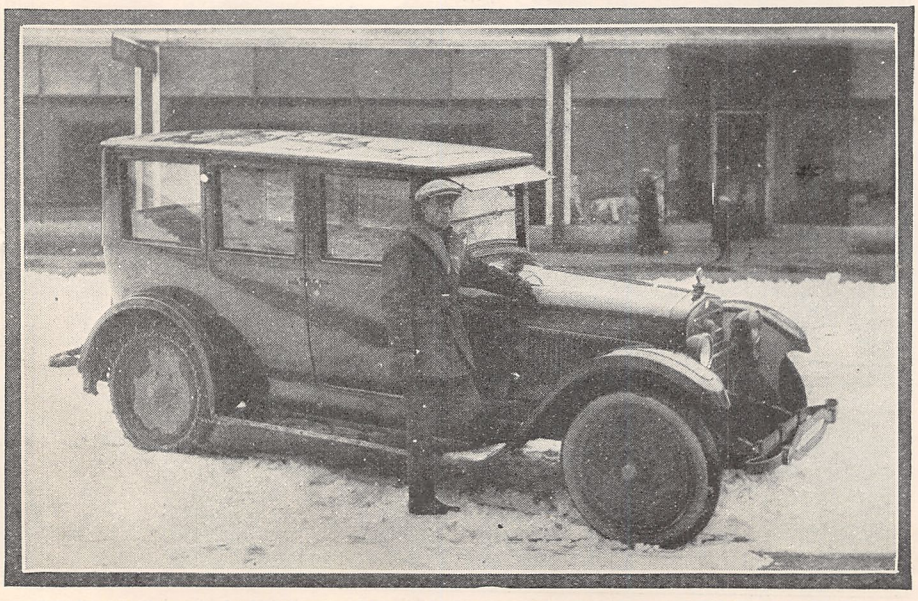
The super-heterodyne which was installed in the car is here shown. It measures but 18 by 2 by 2½ inches and the tubes take up more room than the set.

ECCENTRICITIES OF RECEPTION

Many interesting things have been noted, however, while traveling in the vicinity of broadcast stations with such an outfit. It has been found impossible to receive a station two miles away, while standing at one curb of a street in a large city; but the station came in a-roaring when the car was swung over to the other curb. Steel buildings, elevated structures, etc., may offer very effective shielding at times. Even a motor bus of steel construction will make its presence felt as it passes.

If the plates of the tuning condenser are not rigid, they will vibrate with the motion of the car and affect the reception markedly Loose connections and semi-rigid construction must be absolutely taboo for the same reason.

Using the three-tube outfit mentioned, we were able to receive some broadcasting at night at any point on the open road between Chicago and the East Coast; mostly with headphones, but now and then on the loud speaker, depending, of course, on the distance from the transmitting station. Such an outfit will bring in a perfect medley of short-wave amateur code, at any hour of the night, in almost any location. The trip was made with this outfit from Chicago to Pittsburgh, Boston, Cleveland, and back to Chicago again, with the tubes always in the set ready to use and without a single breakage of a tube. No attempt was made to cushion either the set or the tubes, and no vibration or microphonic noises were experienced.



Mr. Flewelling is here shown with the automobile in which he is making the tests described in this article.

THE INTERNAL ANTENNA

If you wish to assure real loud speaker operation from a receiver in a moving car, at any reasonable place, your choice dwindles down to the powerful "super-het," super-regenerator or receivers designed for loop work; or else your antenna must go up through the top of the car. It is easy to operate almost any receiver if you elevate the antenna above the car; and your reception will be almost in proportion to the actual elevation of the antenna above the frame of the car.

True success in automobile operation comes, however, when no external antenna or loop is used, to mar the appearance or safety of the car, and the receiver itself is so compact as to occupy a minimum of the interior space.

If you use a loop-type receiver, the loop will be a nuisance inside the car, and even more so on the outside. Again, if no visible means of collecting energy are to be seen, there will be less opportunity for interference with the driving. The best solution of the problem is the use of a loop-type receiver, with an input coil for tuning, which

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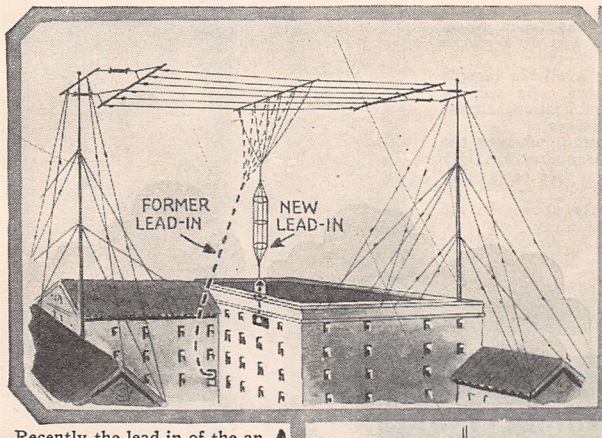
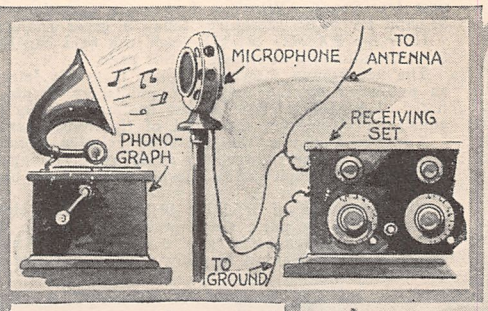
Radio Happenings of the Month Illustrated

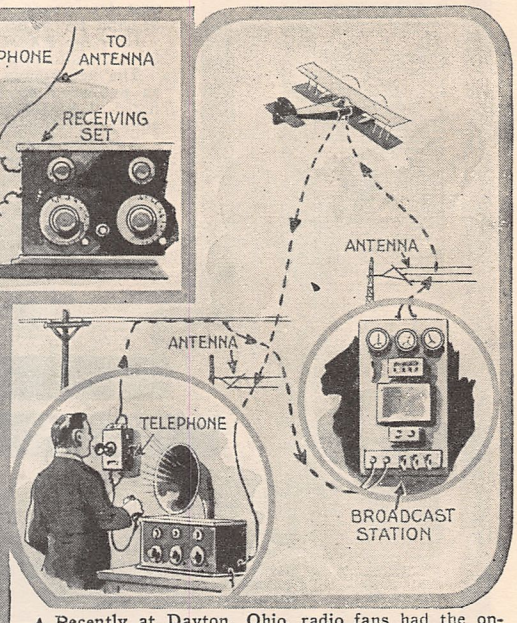
By GEORGE WALL



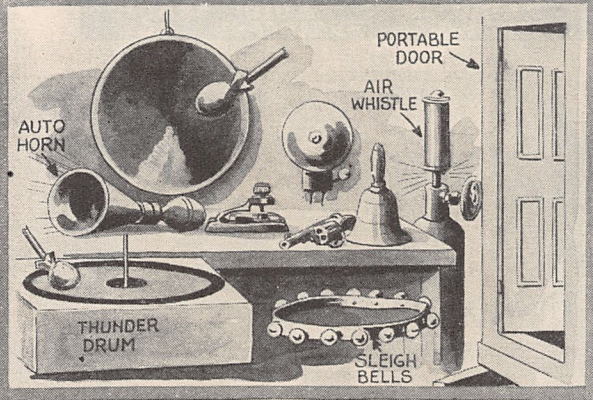
Recently the lead-in of the antenna at station WRNY, the RADIO NEWS station in New York City, was changed from a long single wire to a relatively short cage type. This change lowered the fundamental frequency of the antenna and eliminated the series variable condenser that had been hitherto necessary. The transmitting efficiency of the station has been increased about 60 per cent by this change, as you may have noted.



During the International Tests many DX listeners were fooled by a joker who faked European announcements and program, thus.

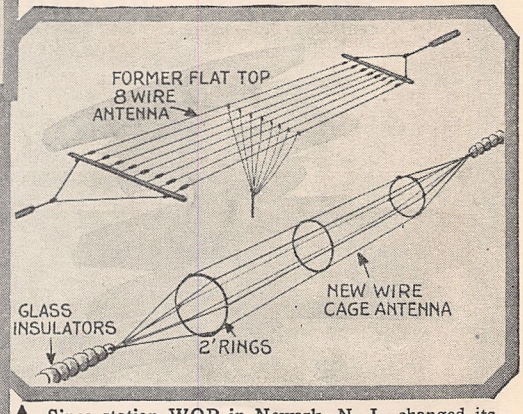


Recently at Dayton, Ohio, radio fans had the opportunity to hold a two-way conversation with an aviator flying 3,000 feet above the city. They called the broadcast station by phone, which was connected to the speech amplifier and thus broadcast to the plane.

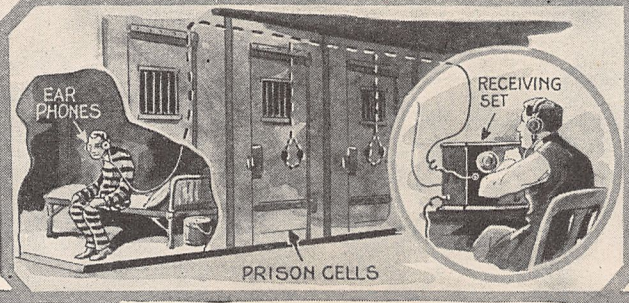


Station WGY, in Schenectady, N. Y., was one of the first to broadcast radio plays. As every illusion on the invisible stage must be put across by sound alone, there are many different devices used, a few of which are shown above.

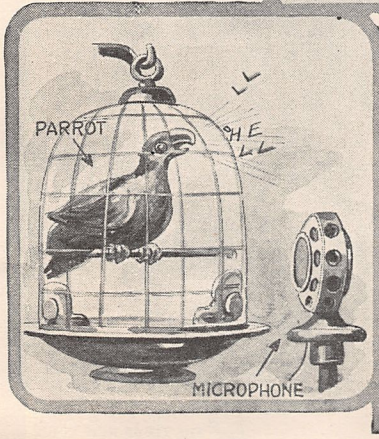
At one of the New York City stations, which broadcasts every evening from a café, the artists have decided that they can put their songs and patter across better if the microphone is "dolled up." Therefore the fancy appearance of the "mike."



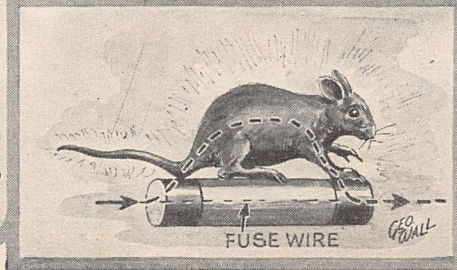
Since station WOR in Newark, N. J., changed its antenna, from one having eight wires in a flat-top arrangement, to a cage type, the station has been heard in Russia; and reception as a whole has improved as a result of this change.



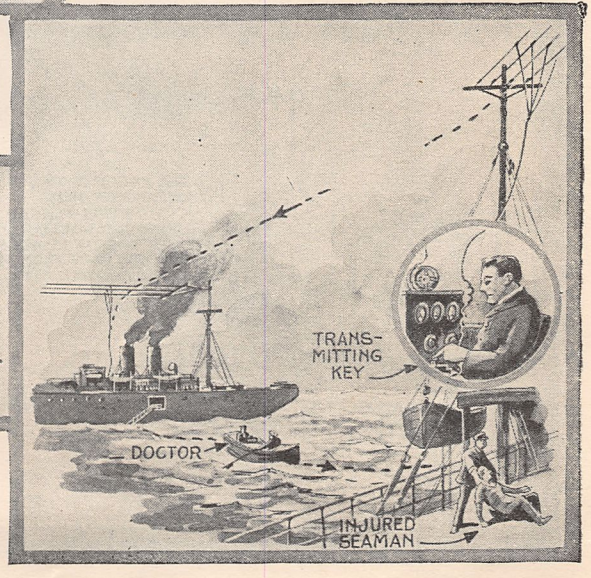
In the penitentiary at Ft. Madison, Ia., radio headsets have been installed in each cell in the death-house, and connected to the large receiving set of the institution. Prisoners who are not condemned to be executed are also allowed to have head-sets, but have to buy them.



Two macaws swearing away at a great rate have been heard several times over station WRC, in Washington, D. C. These birds are kept in the patio of the Pan-American Building and their chatter was unwittingly broadcast along with the Latin-American concerts.



A small mouse was responsible for stopping the program the other night from station CKAC in Montreal. The animal got across a fuse, and was burnt to a crisp.



Radio saved the life of a seaman recently when a physician was summoned from the S.S. Berlin to the Hanover.

Radio Publications In America

Radio publishing has grown to tremendous proportions during the past few years. Where a few years ago there was only a small demand for radio literature, today a great change has taken place.

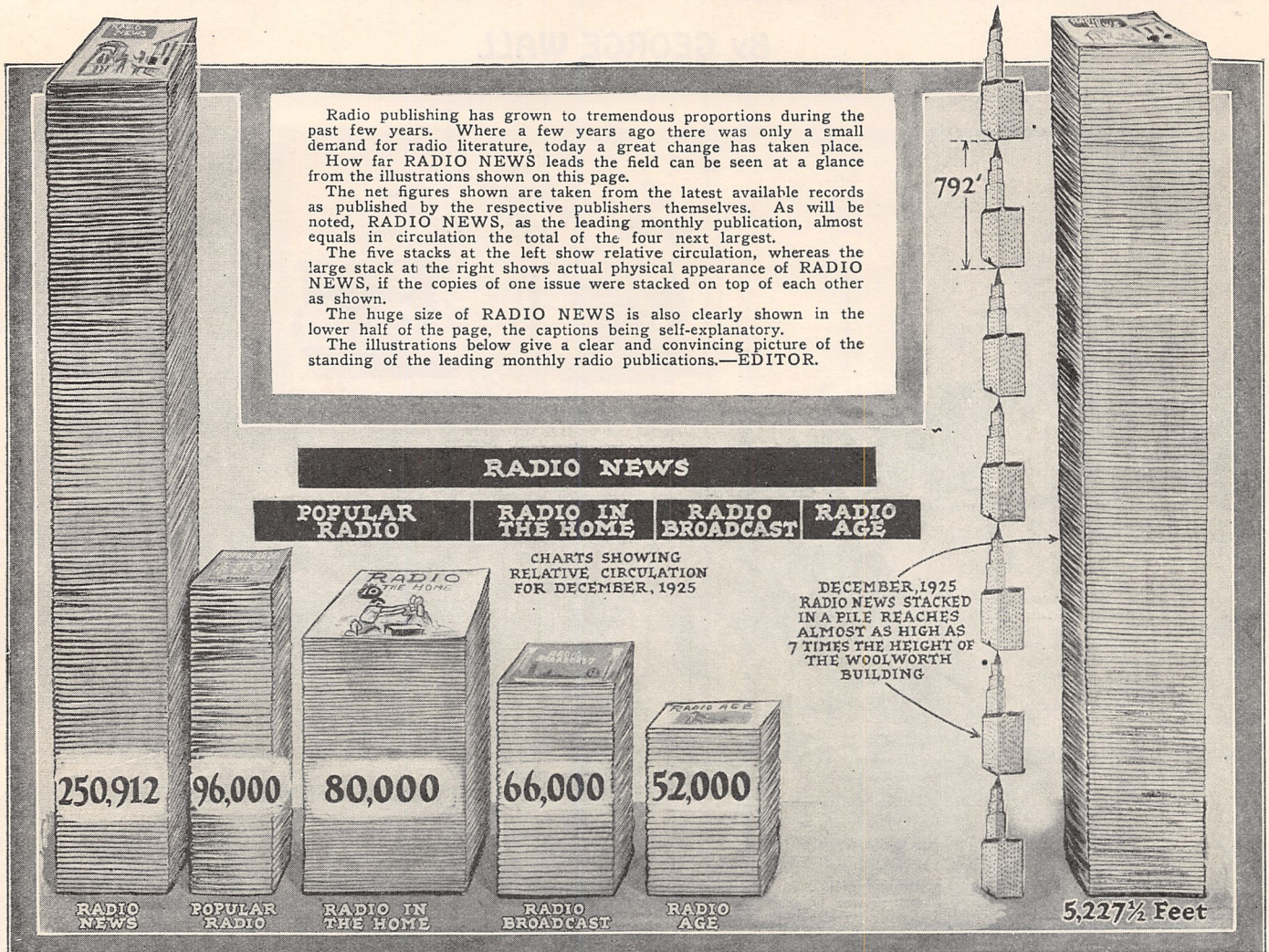
How far RADIO NEWS leads the field can be seen at a glance from the illustrations shown on this page.

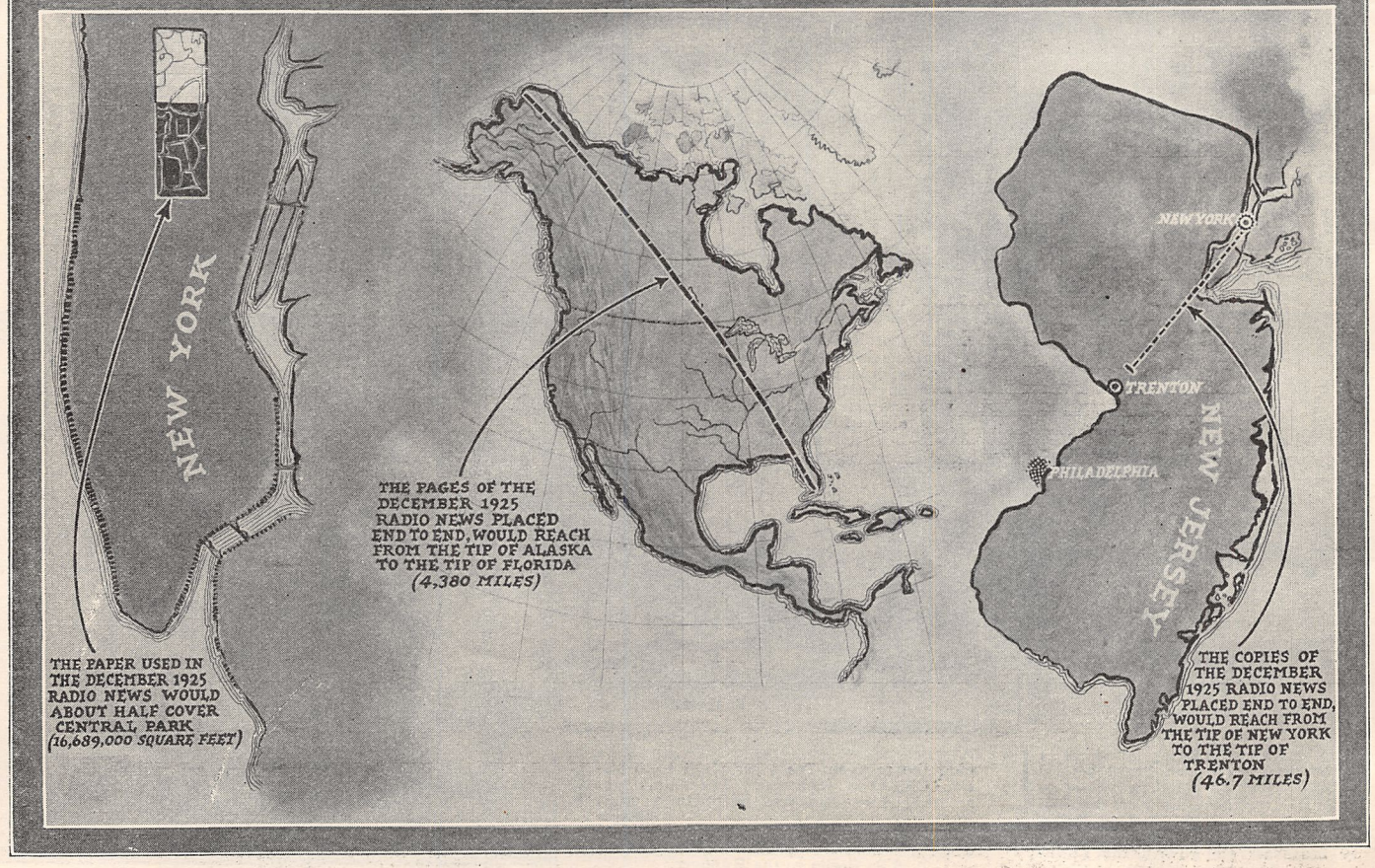
The net figures shown are taken from the latest available records as published by the respective publishers themselves. As will be noted, RADIO NEWS, as the leading monthly publication, almost equals in circulation the total of the four next largest.

The five stacks at the left show relative circulation, whereas the large stack at the right shows actual physical appearance of RADIO NEWS, if the copies of one issue were stacked on top of each other as shown.

The huge size of RADIO NEWS is also clearly shown in the lower half of the page, the captions being self-explanatory.

The illustrations below give a clear and convincing picture of the standing of the leading monthly radio publications.—EDITOR.




NEW YORK
THE PAPER USED IN THE DECEMBER 1925 RADIO NEWS WOULD ABOUT HALF COVER CENTRAL PARK (16,689,000 SQUARE FEET)
THE PAGES OF THE DECEMBER 1925 RADIO NEWS PLACED END TO END, WOULD REACH FROM THE TIP OF ALASKA TO THE TIP OF FLORIDA (4,380 MILES)
NEW YORK
TRENTON
PHILADELPHIA
NEW JERSEY
THE COPIES OF THE DECEMBER 1925 RADIO NEWS PLACED END TO END, WOULD REACH FROM THE TIP OF NEW YORK TO THE TIP OF TRENTON (46.7 MILES)

"Try and Get 'em!"

By N. B. PLATT

Were you among the thousands who had the same experience during the International Tests as Mr. Platt or were you one of the offenders? Read this article and give heed.

"AND it came to pass in the year 1926 that there was conducted a series of tests of the radio with the continent of Europe. There were speech-making, singing of songs, playing of music and other amusements sent on the ether waves from both sides of the Atlantic Ocean; but on the American side of the great water the reception from the stations in the Old World was indeed poor."

This paragraph will doubtless be found, fifty years hence, in the history books of the happenings of radio. In fact, fellow B.C.L.s, we could write a history right now and tell what *we* think of these International Tests, couldn't we? It would not be surprising to see, in history books of the future, the well known saying at the head of this effusion attributed to the fans *de la T. S. F.*, who tried to pick up stations across the drink during the recent tests.

Yes, the writer also tried to pick up stations in Europe. When the announcements were first made I just went wild with joy. American stations were going to sign off and let us get a crack at England, France and every other place that ever heard of radio. Around the office every one of the fellows, who had a set—and it did not matter whether it was a crystal or a super-het—was all pepped up over the fact that here was the chance of a lifetime to yank in some honest-to-goodness DX that *was* DX.

I beat it home the first night after I read the announcements in the papers, and what I didn't do to the old set was not thought of. I tested every connection, I cleaned everything there was to clean, I heaved all the old "B" batteries out in the ash can, I started charging the storage battery—well I did everything I could think of to make the old five-tuber young and handsome and full of "wim and wigor and witality." When she was all prettied up, then I sat me down and decided that I would get lots of practice in tuning in far-away stations. So, until the well known "wee sma' hours" of the mornings, I sat in front of the dials and twisted and turned and heard many stations. The old set was working better than she knew how.

And then came the week of the tests!

"DEFRAUDED IN DELAYS"

Sunday night, as soon as supper was over, I beat it to my room and watched the clock's minute hand loaf around. Never had it seemed to move slower. I thought it had stopped a dozen times and even seriously wondered once or twice if it were running backwards. I was listening to WEAF over in New York—just for practice—and finally they signed off for an SOS.

"That's luck," I thought, "now I'll get a crack at Europe before the regular time."

However all that came in over the cans was a great big volume of silence, with here and there a squeal or two from some blooper. The thought came to me then that Europe had signed off too and I waited until the scheduled hour.

When the minute hand finally crawled around to 12 I slapped on the cans again, and then followed as feverish a few minutes as I've ever spent in my not-too-long life. I twisted and I turned—the dials, I mean—but nary a peep from Europe. I looked in to see if the tubes were perking, they were O. K. I began to get worried and quickly tested the storage battery. That was O. K. too. But no Europe.

And did I get anything that first night? Yes, I did! I'll tell the whole wide world I did! I got the most beautiful and weird and awful collection of howls and squeals and yelps that were ever heard outside of a dog-and-cat farm. There were short little "tweets"; there were prolonged "yoooowwwllllss," that sounded like the lost souls of forty thousand cats bewailing their fate; there were—why go into details? If you listened in you know what it was like, as well as I do. After about fifteen minutes of that, do you blame me for viciously pushing in the filament switch and heaving the phones across the room? I'll bet you a nickel you don't. Honestly, wasn't it awful?

I thought maybe I was unlucky in living in a crowded section of the city and that if I took the set somewhere else the next night, conditions might be better. However that thought struck me before I went to the office the next morning. There ensued a general indignation meeting of those who had tried to get Europe the night before. Fellows who lived out of town, were swearing by all they held holy that they were going gunning for So-And-So, who had a blooper near them. In fact I heard so much, that I decided that the only place to get London stations during the International Tests would be somewhere in King George's back yard.

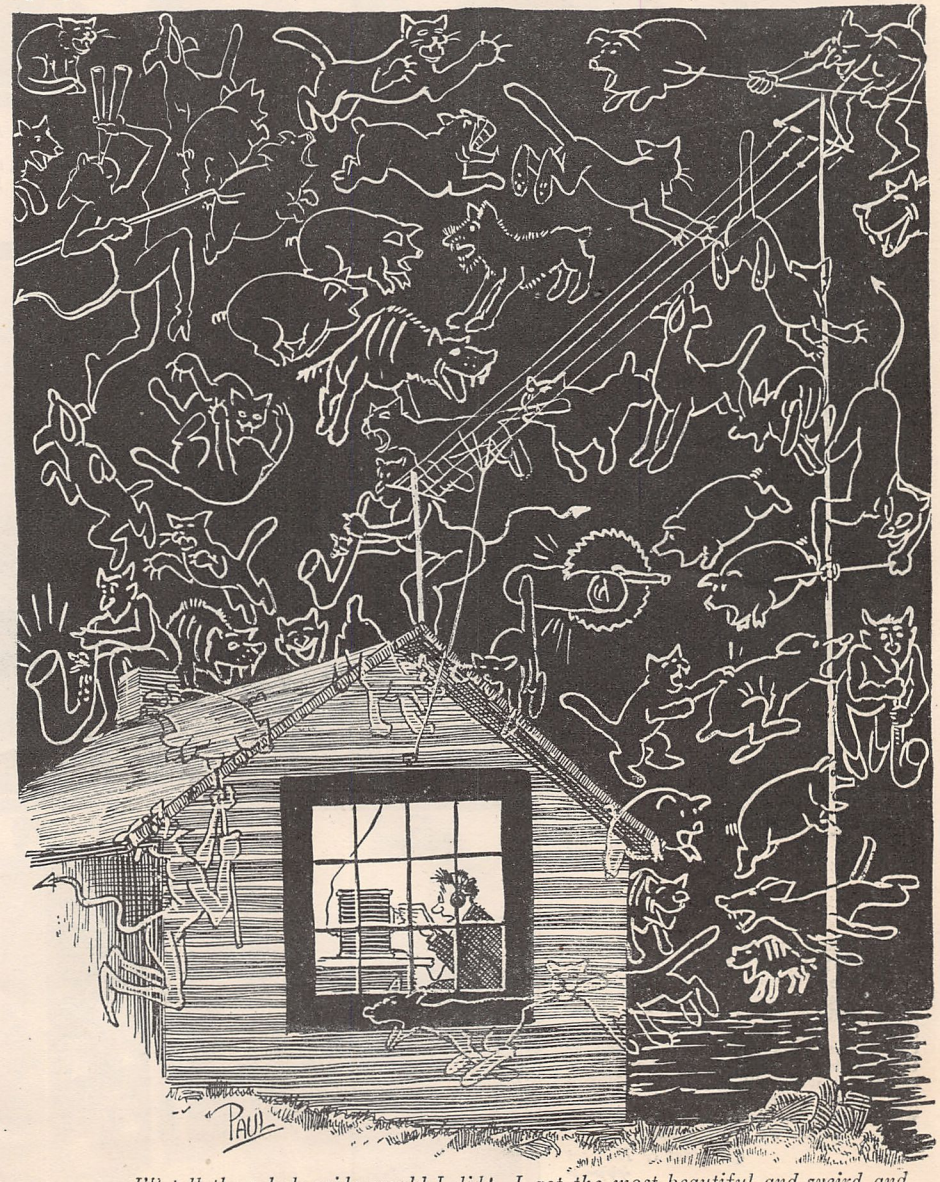
A couple of nights later I was listening in on a friend's super-het, and when 11 o'clock rolled around he suggested that we try for Europe. I laughed at him and told him my experiences, but he thought that "maybe there were others who were disgusted too and had quit."

The truth of the matter was that every other fan in the vicinity must have had the very same thought, for the cat-calls and other distressing noises were in evidence as much as the first night I had listened-in. We soon gave up trying, and started in to play pinochle. We got more action out of that.

KILL OFF THE BLOOPERS

Now I have heard that over in Europe, in some countries, there is a law forbidding regenerative receivers. Of course in

(*Continued on page* 1593)

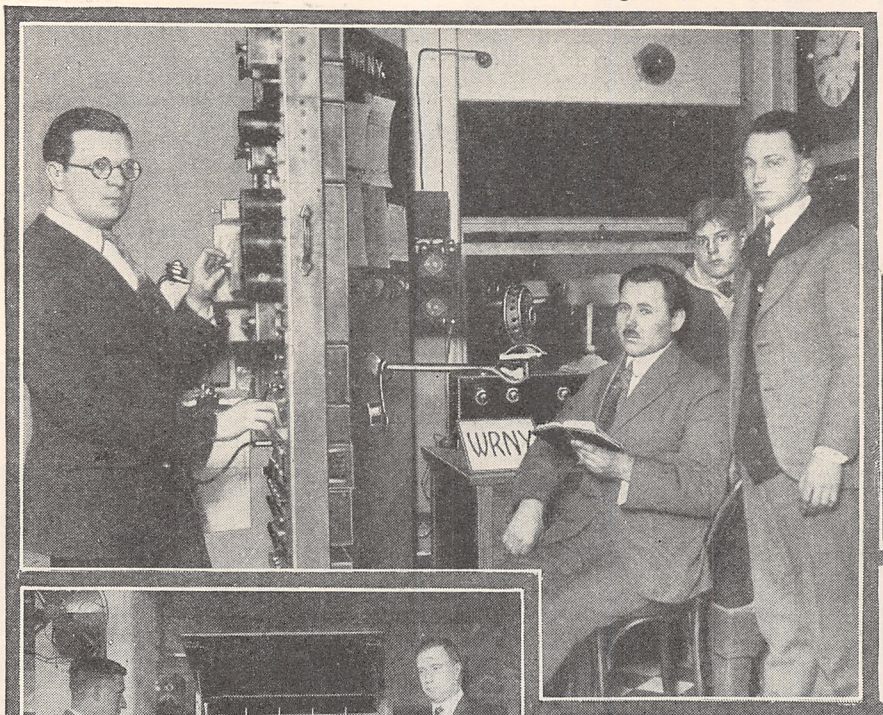


. . . *I'll tell the whole wide world I did! I got the most beautiful and weird and awful collection of howls and squeals and yelps that were ever heard outside of a dog-and-cat farm.*

Novelties From Here and There in Radio

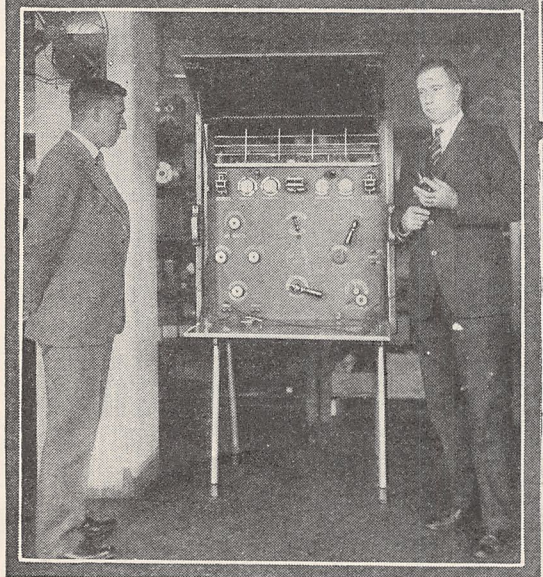
HE BROADCAST PREDICTION OF NEW YORK'S DESTRUCTION. Robert Reidt, Seventh Day Adventist, broadcast through station WRNY, his prophecy, that during the week of February 6, New York City would be destroyed by fire from heaven. The city is still in a healthy condition.

© *International Newsreel*



AN INNOVATION IN "MIKES." Station WHAP, one of New York's newest stations, uses two microphones as shown in the above illustration. It is claimed that this pick-up system is superior to the one generally employed.

© *Fotograms*

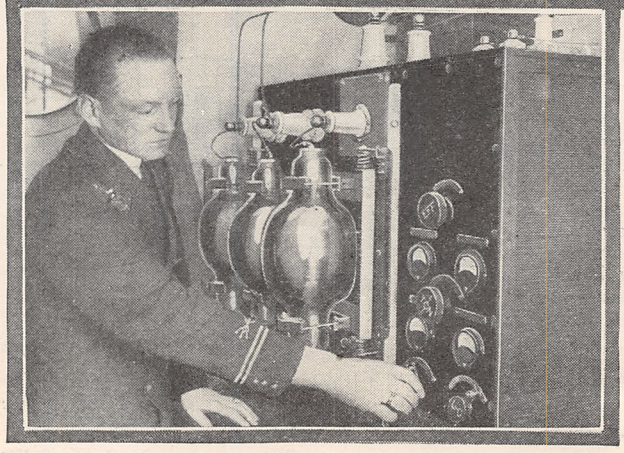


NEW TRANSMITTER MAKES COMMUNICATION FROM GROUND TO PLANE PERFECT. This new 400-watt transmitter, which has a range of 100 miles for telephone and 350 miles for telegraphic communication, has been developed in the laboratories of the U. S. Army Signal Corps.

© *P & A Photos*

ULTRA-MODERN RADIO EQUIPMENT ON SWEDISH MOTOR LINER. The "Gripsholm" has not only very modern marine equipment, but her radio outfit is of the latest type. There is aboard a 1-KW. transmitter, which can be used for telephone, as well as telegraphic communication. The entire equipment was built in Sweden. Notice the shape of the transmitting tubes, which differ radically from those with which we are familiar.

© *Kadel & Herbert*



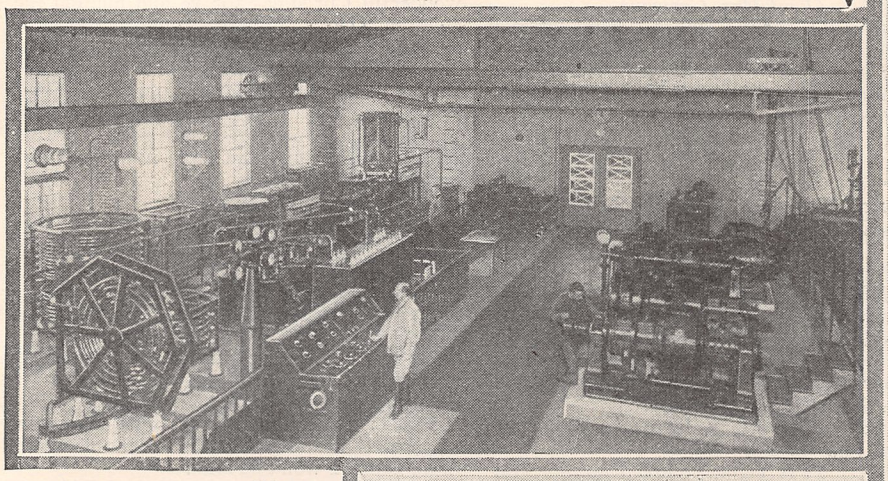
A RADIO SET WITH THIRTY-TWO LOUD SPEAKERS. To permit a careful comparative study of the many different types of loud speakers, a New York radio enthusiast has thirty-two loud speakers connected to his receiving set. By means of a switching device, any of the loud speakers can be switched in while the set is in use, thus permitting a careful comparison to be made. An interesting feature of the arrangement is that a miniature electric lamp in front of each speaker is lighted by the current which operates the latter, showing just what instrument is in use.

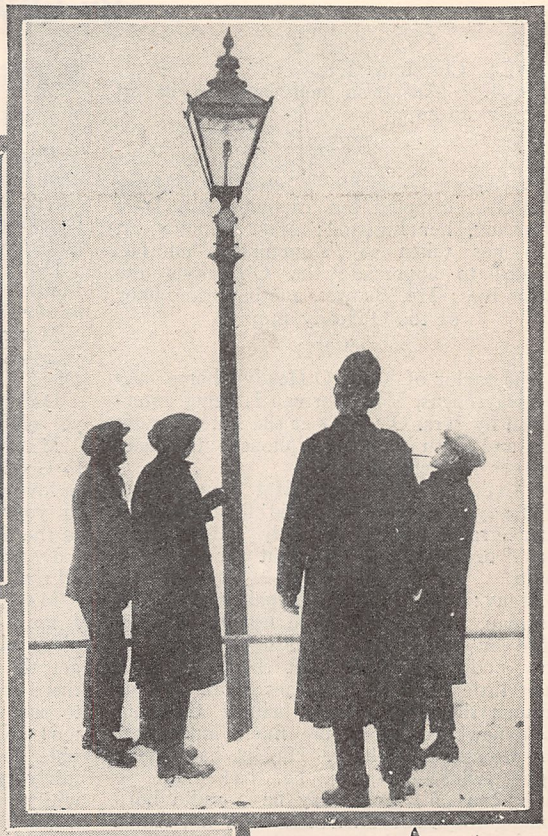
© *Kadel & Herbert*

New European Super-Power Radio Stations

CONTROL ROOM OF BIG NEW GERMAN RADIO STATION

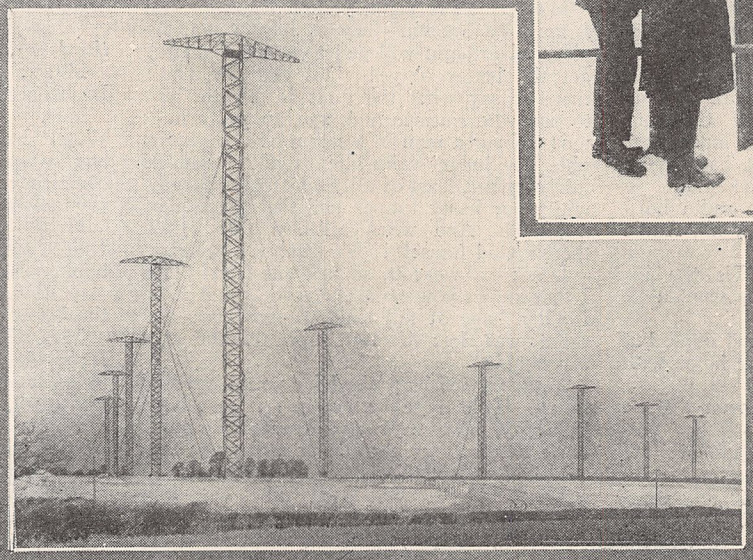
The illustration below gives an idea of the great size of the control room of the new broadcast station at Koenigswusterhausen, a suburb of Berlin. At the right of the room is the bank of generators which supply power for operation; and at the left the 50-kw. high frequency automatic transmitter and the 32-kw. low frequency transmitter.
© *Wide World Photos.*





TO LINK GREAT BRITAIN WITH DOMINIONS BY RADIO

To the right is an illustration showing the new Marconi station just completed at Bodmin, in Cornwall, England, for communication with Canada and South Africa. There are similar structures at Bridgewater, England (a receiving station) and at Montreal and Cape Town. Short-wave beam-transmission will be used; of the ten masts at each station, each row of five is at right angles to the direction of communication from that set to one of the dominion stations. Each mast is 277 feet high and the cross-arm 90 feet long. © *Kadel & Herbert.*

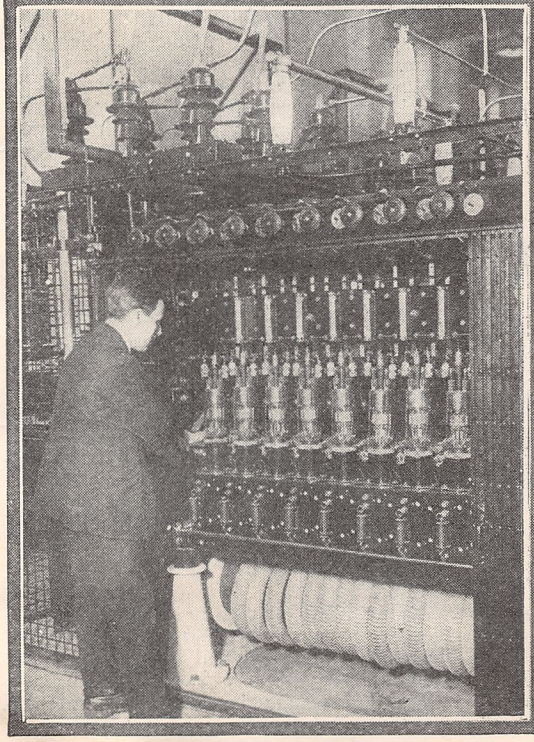


HILLMORTON SUPER-POWER STATION

This new English broadcast station claims the highest power in the world, with forty times as much as has been in use at Daventry. © *Photopress.*

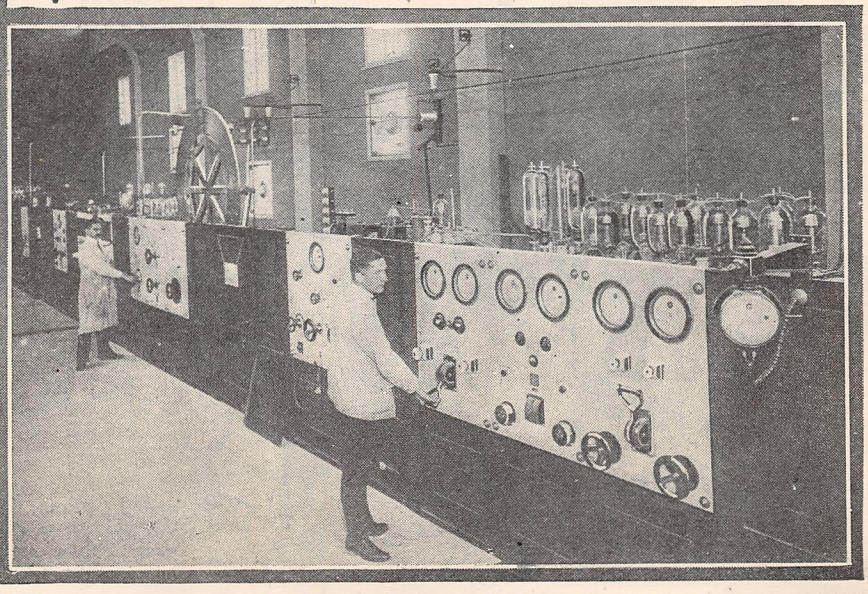
THE RADIO MYSTERY LAMP-POST

This electric light at Essex, England, is reported to be receiving the programs from 2LO, London, to the entertainment of the police and other passers-by at lonely hours. Engineers attribute the reception to the arc-light at the top, which in some manner acts as the equivalent of a receiver, but the exact method is in doubt.
© *Wide World Photos.*



THE CONTROL SWITCHBOARD AT KOENIGSWUSTERHAUSEN STATION

Another view of the new German station shown at the top of this page, which has one of the most elaborate switchboards in the world. The immensity of this outfit can be judged from the picture; two men are kept busy manipulating the controls during transmission. This station will handle commercial messages, as well as broadcast radio programs.
© *Wide World Photos.*



A Radio Christmas Carol

$50.00 Prize Winner in the Radio News Play Contest

By EDWARD CECIL GARRETT

TIME: Christmas Eve.
PLACE: An Irish neighborhood in an American city.

CAST

MRS. ANNIE GORMAN, a neighbor; MARY O'HEADY, crippled but capable; BIG DAN O'HEADY, her husband; MRS. BROCKHART, who has taken to "slumming," but has learned to appreciate the O'Heady's for themselves; MR. BROWN, another benefactor of the O'Heady family.

SCENE

The parlor of Mary O'Heady's home. As the play opens, Mrs. Gorman is being entertained by Mrs. O'Heady at the latter's radio set, and both wear headphones; the loud speaker is silent.

ANNIE: 'Tis a beautiful tune, Mrs. O'Heady, but 'twould sound finer even on your grand horn! If only Santa Claus would bring me one like that for my boy's radio!

MARY: Aye! A grand spaker it is, Mrs. Gorman, and soon ye'll be hearing it agin. Sure but the children must be aslape by now, and good ould Saint Santy is filling their little heads with drames of all the fine prisints the morrow may bring! Och, but your newborn babe's the finest loudspaker any woman could have. Ha, ha, ha—saving 'twas twins!—Ha, ha, ha, ha! But ye niver can tell, there may be a radio horn coming to ye for Christmas after all, Annie Gorman!

ANNIE: 'Tis wonderful! 'Tis the invention of hivin itself. A lucky woman ye are!

MARY: I am that, all said and done, but (*sobbingly*) if only my Dan were home with me for Christmas———

ANNIE: There now, Mary, soon will he be home and he'll stay home, I'm thinking.

Sit ye down, Mary and niver a step! Don't be rising!

(*Exit Mrs. Gorman*).

MARY:—(*A gentle knock sounds at the door; she's not sure she has heard or not and listens intently*) Now what was that? (*Loud knocking*) I'm comin,! (*hobbles to the door and opens it*).

DAN: Mary! Mavourneen! Don't ye be faintin', 'tis your own Dan! (*Catches her as she lurches forward*).

MARY: Dan, my own big Dan! Is it yourself indade, or do my eyes desave me? Dan!

DAN: 'Tis myself indade—this will show ye! (*Kissing her resoundingly*).

MARY: Indade it is yourself! Glory be to God! But ye crush me, Dan. . .Och! If in love ye hug that terrible, it is God's mercy in your anger ye didn't crush that snake to the death!

DAN: Whist, Mary, let us be forgettin' all that and———

MARY: Ye're right, ye are, Dan, but first I must be knowin'—beyont iver a doubt—niver, niver, agin will ye let yer black temper get the better o' ye! 'Tis the law that's there to say what the guilt is, 'tis the law to pass the sintince and, aye, to perform it too! Niver a man in a storm of a timper is able to judge calm-like, and to punish fairly ayther, least of all ye, Daniel O'Heady, with your hasty timper and the strength of a giant! And when all else fails, Dan, there's God himself! Ye sware . . .niver.

DAN: I swear it, so help me God! 'Tis I that knows you spake the truth, my darlint. I did a hape of tall thinkin'—up there, and there was lots o' time fer thinkin' too. Niver agin!

MARY: God be praised for your change o' heart! I love ye better than iver, Daniel O'Heady, because ye have worsted the black baste that was tryin' to do ye. . .In your eyes 'tis plain, ye are the master of yourself.

DAN: Do ye know, Mary, all down along the line I could see they spotted me as being just out of the pen, but no diffrince it made to the kindness of ivryone. I tell ye there is a wonderful spirit in the air the while and——

MARY: Sure! 'Tis Christmas! And a wonderful Christmas for ye and me and the children, Danny. There's some fine prisints a-comin' from the company I'm ixpictin! 'Tis a rale genuine lady, but for all the wealth of her, I feel in my heart she's sad, rale sad. . .and there's our grand gintlemin frind, Mr. Brown, he that gave me that radio set, 'tis yours and mine now, Dan, and ye can have hapes o' fun and fine music right here in your own home, niver costin' one penny. Mr. Brown has a sadness too, or badly I'm mistaken. If only poor Mary O'Heady could make thim happy agin for Christmas! Och, they have been most wonderful kind and thoughtful of your family, Dan O'Heady.

DAN: 'Tis ye that make the fine frinds with yer own swate disposition, Mary. (*A knocking at the door*).

MARY: That's thim I'm thinkin'. Now, step softly upstairs and don't wake the children, Dan. I won't be long.

(*Dan goes upstairs and Mary hobbles to the door*).

MARY: Come in and God bless ye, Mrs. Brockhart!

MRS. B: Thank you so much. Tell me—Why! I see you are looking years younger, and *so* sprightly! What good fortune has come to you? You will have deserved it if ever anyone does!

MARY: The best of fortune, Mam. My Dan is out of. . .jail, home for Christmas. . . home to stay, not just on ticket o' leave, and stay he will, Mam, for a changed man for the better he is.

MRS. B.: Wonderful! I am so really *truly* glad! And this is Christmas Eve! Why, it sounds like a fairy story, a Christmas carol, rather———

MARY: 'Tis all o' that, Mam, the goodness of God himself, and of ivryone else, too, ye the most of all———

MRS. B.: You have done for me far more good than any thing I may have been the means of doing for you, Mrs. O'Heady. Here are some little gifts for the children, and there's something special for yourself.

MARY: Thank ye, thank ye, bless ye, Mam, but 'tis another favour I'll be askin'! A happy woman is a bold woman, Mrs. Brockhart, and ye'll not be putting me off? There's more company ixpicted, Mr. Brown.

MRS. B.: Mr. Brown?. . .Oh, you mean the gentleman who gave you the radio?

MARY: Himself, it is, Mam, and he is just your style, Mam, might I make bold to say, a rale kind-hearted gintleman if iver there was one. Will you not care to mate him, Mam?

MRS. B.: Really, I shouldn't. . .he might start talking about radio?

MARY: Och! Now, ain't that somethin' to be rale thankful for?

MRS. B.: No, not in my case! It has caused me lots of unhappiness and . . . . . .

MARY: 'Tis sad ye are and well I know it, Mam, but to think the radio of all things should be the cause! 'Tis a queer wurrld it is!

MRS. B.: Oh, I suppose I shall tell you everything, Mrs. O'Heady. I can see that nothing but the truth will satisfy you, and perhaps I shall feel the better for confessing to. . . . . .

MARY: 'Tis manin' to help you, I am, like the poor she-mouse as helped the big fine lion! And God will help me to repay your kindness, Mam, I feel it here!

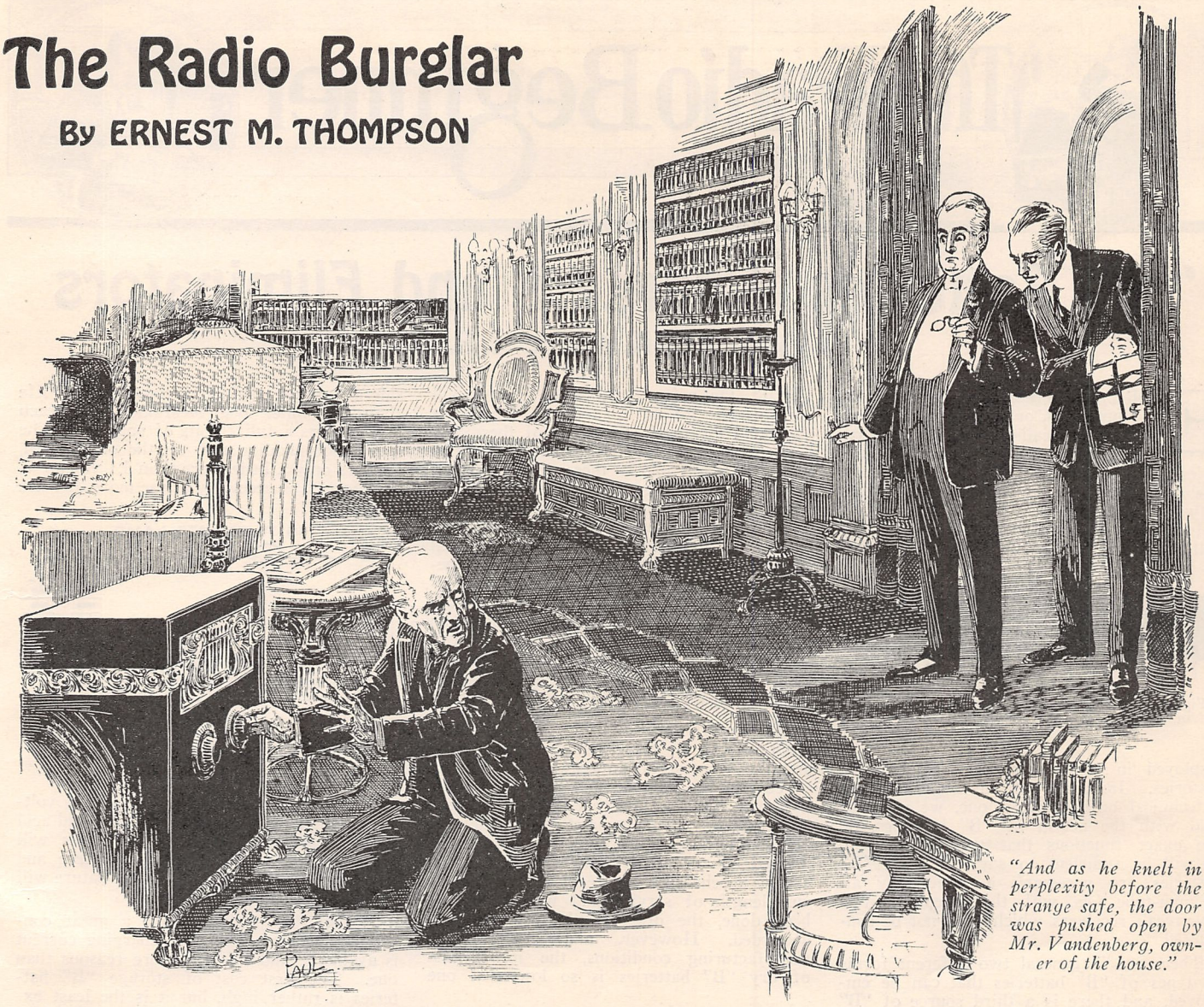
MRS. B. (*Understandingly*): You see I

(*Continued on page* 1604)

Mary: "Faith, then 'tis Christmas all the year 'round in the heart of ye, sir!"

The Radio Burglar

By ERNEST M. THOMPSON



"And as he knelt in perplexity before the strange safe, the door was pushed open by Mr. Vandenberg, owner of the house."

THE long train moved like a snake along the bank of the Hudson, following the curve of the river. The old-fashioned burglar swayed and lurched as he tried to keep his footing while walking back through the last car. He considered, smiling a bit sardonically, that he had forgotten how to do even so prosaic a thing as to ride a train. Fifteen years behind iron and stone makes a difference, especially when taken out of the middle of a man's life. It was like coming back from a foreign country. The occasional visitor to the prison at Ossining had not been enough to impress upon his mind the fact that fashions had changed. He felt decidedly uneasy among these women whose legs were visible to the knee. When he had said good-bye to his wife in nineteen-ten, her skirts were long enough to sweep the pavement. But she was dead, now, like the whole world that he had left outside the doors of the prison, in nineteen-ten.

The old-fashioned burglar stood on the platform of the last car. He lit a cigarette, enjoying the wonder of the thought that now he would be able to smoke any time he wanted to. He was free, and need take no more orders! But when the conductor shouted to him, pointing to the sign that forbid passengers to ride on the platform, he shambled obediently back into the car, stepping on the half-finished cigarette.

As the train wound on past Tarrytown and Yonkers, the old-fashioned burglar revolved in his mind the question of the future. Only one thing was certain in his mind. He was going straight. Although his wife had died, he had to consider his son, who had written that he was doing well in a new-fangled business called "radio."

"It's bad enough to have a jail bird for a father," mused the old-fashioned burglar: "I can't run the chance of getting him into further trouble. I've got to go straight."

As the train swept in past Spuyten Duyvil, and apartment houses began to appear, the old-fashioned burglar noticed that the roofs were all sprouting with various kinds of masts and towers, and that every building was literally encaged in wire. This was queer, but no queerer than the immense trousers and flaming sport sweaters of the youths he could see from the car windows; so he gave it little thought, and decided that the best way to become a part of the world again was to think nothing that he saw at all remarkable. So he pulled from his pocket the last letter from his son Kenneth, and read it over again. There was one paragraph over which he lingered:

"Of course, Dad, you will stay with me. I have rooms over the store, for the present. And no one need know where you've been. The Bronx is far enough from Albany, I guess, to keep any of your old friends from bumping into you. I've been telling people that you were an invalid, but that we had hopes that the Canadian air would make you well again. Just remember that you've been recuperating in St. Mary's hospital in Lakeville, Ontario, and that you didn't know anyone outside of the hospital while you were there. And don't forget either that I have a big surprise for you when you get here. Don't plan to be doing anything on April twentieth."

"April twentieth," reflected the old-fashioned burglar, "That's the day after tomorrow."

Kenneth met him at the station. Neither had much to say. It was five years since they had seen one another, for the boy had been an assistant radio operator on an English ship for four years; and on his return the father had requested that he wait until the sentence had expired before they met again. Kenneth had seen enough of the world to know that the outcasts of civilization are not of necessity evil or repulsive creatures. He was not resentful about his father's prison record, and, with that out of the way, found him a rather tired and prematurely-old man with kind eyes glancing out from his pallid face.

The old-fashioned burglar was genuinely proud of his son, but had nothing to say on the matter. They sat in the subway, occasionally looking at one another, and gradually the first embarrassment of their meeting melted.

"I've got to find something to do, Ken," announced the old-fashioned burglar. "No more safe-cracking for me. There'll be some that'll call it a shame. I was a king at it, in my day. I could open any safe without a tool to help me. That's *talent!* But it'll be talent wasted from now on. I'm going to tread the straight and narrow."

"There'll be work for you in the store," said Ken, cheerfully. "That is, if you don't

(*Continued on page* 1589)

"B" Batteries, Chargers and Eliminators

By A. P. PECK, Assoc. I. R. E.*

EVERY radio receiving set that uses vacuum tubes, or audions as they are sometimes called, employs what are known as "A" and "B" batteries, and sometimes "C" batteries. In this department, in the last issue of RADIO NEWS, the writer discussed "A" batteries and "A" battery chargers. This month we will consider the second type of batteries

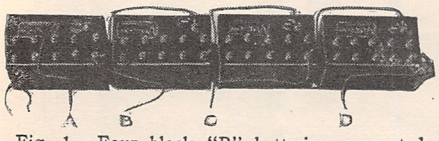


Fig. 1. Four block "B" batteries, connected in series, with taps for various voltages.

employed in radio reception, namely, "B" batteries. Inasmuch as this article is not a technical or theoretical one, we will not deal with the action of "B" batteries, or the exact functions that they accomplish. It will be sufficient to say here that "B" batteries are necessary in practically all vacuum-tube sets, with the exception of a few freak receivers which need not be considered.

There are in general two different forms or types of "B" batteries that can be employed, and there is a third source of "B" potential to be considered. The two types are dry-cell and storage batteries, and will be taken up in that order in this article. The third source of potential is known as a "B" battery eliminator or, more commonly, a "B" eliminator.

CELLS AND BATTERIES

As we have said before, there are two types of batteries. Before we go into the discussion of them, let us clear up one point in connection with these units; that is, the difference between a battery and a cell. The exact difference can be plainly seen when it is stated that a cell is a single unit capable of producing a certain voltage. Regardless of the size of this unit, the voltage produced by it will be exactly the same, but on the other hand, its amperage will vary. A battery is always composed of a number of cells connected together, usually in series. (More about series connections later.) On referring to Fig. 1, you will see an illustration of four "B" batteries connected together. Each one of these "B" batteries is composed of a series of cells. In a 22½-volt block there are 15 small dry cells of the type used in flash-lights. The cells can be more plainly seen in Fig. 2, where a standard type of storage "B" battery is illustrated, in which each cell consists of a test tube containing two metallic strips and a chemical solution. Remember that a collection of cells should never be referred to as anything other than a battery; and that a single unit or cell should never be called a battery. The unit is a cell and nothing more or less.

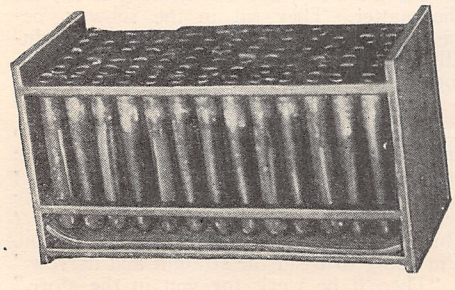
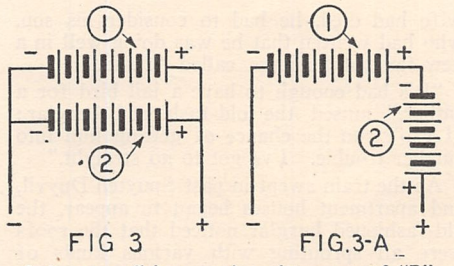


Fig. 2. A standard type of nickel-iron-alkaline storage "B" battery, suitable for practically all types of radio sets.

*Radio Editor, SCIENCE AND INVENTION).

DRY "B" BATTERIES

The use of dry "B" batteries dates back practically to the origin of the vacuum tube; and the greatest advantages of this source of current are compactness, portability, low first cost, and the fact that little or no care is necessary when using them. The dry "B" battery is entirely self-contained and it need not, or rather cannot, be recharged. When purchased it is ready to deliver its full length of service and when that has been done, the dry "B" battery must be discarded. However, under present-day manufacturing conditions, the initial cost of dry "B" batteries is so low that one need not worry about the waste that seems to be present when a run-down "B" battery is thrown away.



Left: a parallel connection of two sets of "B" cells. Right: two sets connected in series.

Dry "B" batteries are most convenient in isolated neighborhoods where charging facilities are not available and where storage "B" batteries would, therefore, not be advisable. A spare set of dry "B" batteries can always be kept at hand as they do not deteriorate very rapidly when not in use and, therefore, constant operation can be guaranteed at all times. If, however, one allows his "B" batteries of the dry type to run down, and no replacements are at hand, the use of the radio set will have to be abandoned until new batteries are obtained.

STORAGE "B" BATTERIES

Storage "B" batteries may be classified in two types. The first is known as the lead-acid type and the other as the nickel-iron-alkaline type. The form employing lead plates and an acid electrolyte requires considerably more attention during its useful life than the other one mentioned, but each cell delivers a full 2 volts of potential. The nickel-iron-alkaline cell, on the other hand, delivers only a little more than 1.1 volts and, therefore, it is necessary to use more of these cells to obtain a battery of a certain voltage than is the case with the lead-acid type. However, both of these forms will be found quite satisfactory in service; and the choice of "B" batteries of this nature will have to be made by yourself.

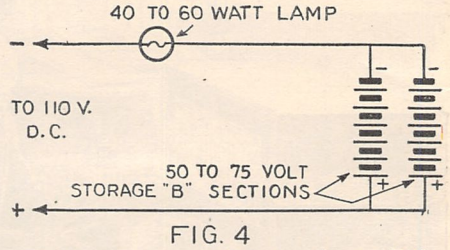


FIG. 4

Charging a storage "B" battery from a D.C. source. The two sections are in parallel.

Storage "B" batteries are a great convenience when a source of charging current is available, and this for more reasons than one. The first cost of storage "B" batteries is rather high, but it is the least expensive over a period of years, if the battery is taken care of. Then again, if your batteries happen to run down right in the middle of an interesting program, you can put them on charge for a period of about 15 or 20 minutes. Then place them back in service again and they will probably operate the set for the rest of the evening. When a "B" battery of the storage type is once purchased, it needs no replacing or renewing for several years with the exception of the charging that has just been mentioned. This is very readily accomplished and several chargers were illustrated in the April 1926 issue of RADIO NEWS that will do this work. For instance, the chargers shown in Figs. 3, 4, 5 and 6 in that issue are adapted to both "A" and "B" battery charging; and may, therefore, be considered almost universal in use.

SERIES AND PARALLEL CONNECTIONS

Before going further into the subject of chargers for storage "B" batteries, let us

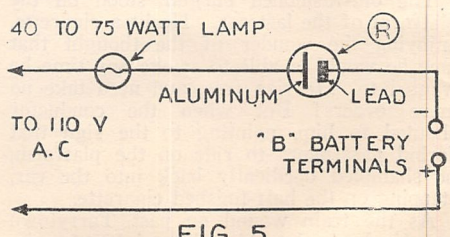


FIG. 5

The circuit of a simple electrolytic rectifier, for charging storage "B" batteries from an alternating-current source.

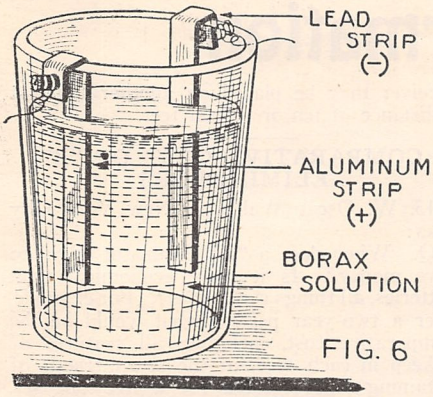


Fig. 6. Illustrates a simple electrolytic rectifier, such as is used in the circuit shown in Fig. 5 on the opposite page.

dwell for a moment on another point. There are two general methods of connecting batteries together and they may be noted as "series" and "parallel" connections. The illustration in Fig. 1 shows how four block "B" batteries are connected together, in *"series,"* so that the voltage delivered by the entire set will be equal to the sum of the voltages of the various blocks when these voltages are added together. This illustration also shows how taps are taken from a series of "B" batteries so as to render various voltages available. For instance, the wire labeled A is the negative connection and goes to the post labeled "—B" on your set. B is a 22½-volt tap for supplying the detector tube and goes to the "+B Det." on your set. If it so happens that you have a tuned radio frequency receiver, it is often found advisable to supply an intermediate voltage to the R.F. tubes and this is accomplished by means of the tap C which should be connected to the "+B Rad." post on your set if such a post is available. If not, the connection C is not used and that labeled D is connected to the "+B Amp." post on your set.

It will be noted that the positive pole of each battery beginning at the left is connected to the negative pole of the battery immediately to its right. This is what is known as connecting batteries in "series." With the arrangement shown in Fig. 1, voltages of 22½, 67½ and 90 volts are available. Of course, the taps B and C can be placed at other intermediate points on the battery and thus variable voltage is obtained. For instance, it may be found that the detector tube works better with 45 volts applied to the plate. Therefore, in a case of this nature, tap B would be moved to the highest positive tap on the second battery from the left-hand end of the series, and 45 volts would thus be supplied.

In the case of storage "B" batteries, a storage "B" battery unit usually supplies 100 volts or more. It is obvious that if the charging source is less than this value, it will be impossible to charge the battery correctly and, therefore, these batteries are usually made in two or more sections and arranged with a switch so that the sections can be connected in series for use and in parallel for charge.

Fig. 3 shows what is known as a *"parallel"* connection. Here there are two storage "B" units and it will be noted that the negative ends of both units are connected together, as are the positive ends. Other connections are then taken from these two common wires and lead to the "B" battery charger, of whatever type may be employed. When such a method is used, the charging rate must be twice as high as would ordinarily be employed for charging in series. If for instance, your battery is designed to be charged at about a quarter of an ampere, and this is the usual rate, it should be charged at half an ampere if it becomes necessary to connect the sections in parallel, as in Fig. 3.

A series connection of two "B" battery units, designated as A and B, is shown in Fig. 3-A. Here it will be noted that the positive pole of battery A is connected to the negative pole of battery B, and leads to the charger or to the set are taken from the remaining ends, one being negative and the other positive. If you have a 100-volt "B" battery and you use a charger capable of supplying a greater voltage than this, you can use the series connection shown in Fig. 3-A. In other words, you will not have to disturb the connections of your battery, in any way whatsoever, when it is to be placed on charge. If, however, your "B" battery charger supplies less voltage than this, which is true of a type that will be described later, you will have to use the parallel connection shown in Fig. 3. If you have a 100-volt "B" battery unit, it should be divided so that it will be in two sections of 50 volts each, and they should be connected in parallel, as described.

HOME-MADE "B" CHARGERS

When direct current is available for charging batteries, the system used is very simple. It is diagramed quite plainly in Fig. 4. Taking it for granted that 110 volts D.C. is available, it is only necessary to connect the two sections of the "B" battery in parallel, as explained above and illustrated

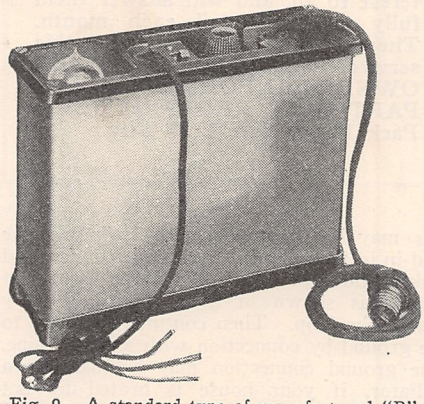


Fig. 9. A standard type of manufactured "B" eliminator employing a special rectifier tube which has no filament and cannot burn out. *Photo by courtesy of Acme Apparatus Co.*

in Fig. 3, and to connect the unit so wired together to the 110-volt D.C., circuit through a standard 110-volt lamp. This lamp controls the current supplied to the "B" battery and for ordinary purposes may be of a size ranging from 40 to 60 watts. If a 100-volt "B" battery is used and is connected in parallel, a 60-watt lamp will give a charging rate of approximately half an ampere. It is necessary in a case of this kind to watch the polarity of the charging current very carefully. In this department in the April issue, (page 1485) a system for determining the polarity of the D.C. line was described.

When only alternating current (A.C.) is available, it is necessary to use what is known as a rectifier, or current charger, in order to charge a "B" battery. It must be remembered that alternating current is just what its name indicates. It is a current that flows first in one direction and then in another, changing its flow rapidly and

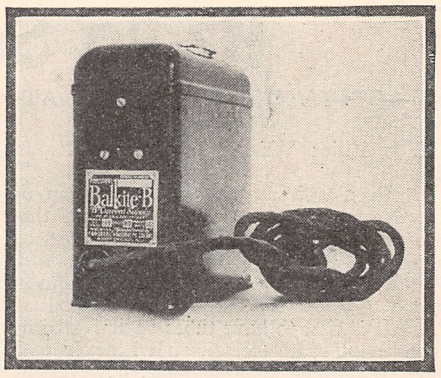


Fig. 7. Another type of "B" battery eliminator employs no tubes at all. It operates on an electrolytic-rectifier principle. *Photo by courtesy of Fansteel Products Co., Inc.*

periodically. We can, however, place a very simple rectifier in the circuit which will allow current to flow through it in one direction only; and thus we can obtain a flow of current that will be suitable for battery charging. The very simplest and most satisfactory method of performing this work for "B" battery charging is to use an electrolytic rectifier, in a circuit such as that shown in Fig. 5. Here, again, when a 100-volt "B" battery is to be charged by this system, the sections must be connected in parallel. The rectifier, connected in series with a 40- to 75-watt lamp, is indicated by R in Fig. 5. Details covering the construction of this very simple rectifier are shown in Fig. 6.

As illustrated, it consists of a strip of aluminum and a strip of lead immersed in a water in which as much ordinary borax has been dissolved as it is possible to cause to enter into solution. (A solution of this kind is termed "saturated.") Before placing the metal strips in it, clean them thoroughly with sandpaper and rub the surfaces until they are highly polished. Then mount binding posts on the ends of the strips as shown, and bend the strips so that they can be hung over the edge of a small glass jar. The solution is placed in the jar as shown in Fig. 6. Now connect up the lamp, the rectifier and the "B" battery as shown in Fig. 5, and turn on the alternating current. A rush of current through the circuit will first take place, as will be shown by the lamp lighting up very brightly, and then this flow will die off until the lamp just barely glows. The charging should be continued until the voltage of the entire unit, when measured with the current turned off, is slightly higher than normal. A rectifier of the nature described needs very little attention. However, it is a wise idea to place a layer of mineral oil about a quarter inch thick on the top of the solution. This effectually prevents evaporation of the water; and by doing this, the rectifier can be used for months without any deterioration whatsoever. Paraffin oil is to be recommended for this purpose, but castor oil must be avoided. It will enter into a chemical action with the solution and will cause trouble.

CARE OF BATTERIES

The writer has often observed, when looking over various installations of radio receiving sets, that the batteries employed seem to be given the least possible attention. They

(*Continued on page* 1597)

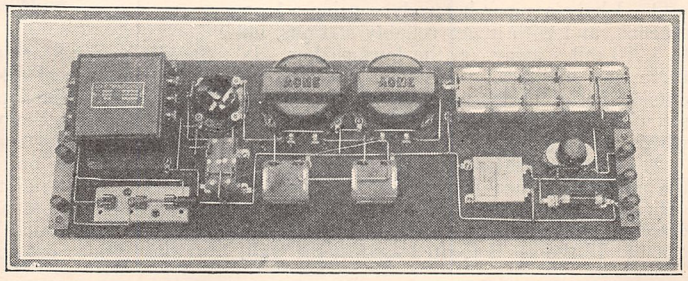


Fig. 8. This eliminator may be built by the home constructor as a permanent addition to his set, needing no further adjustment when once installed. It uses the same type of rectifying tube as the factory model in Fig. 9. *Photo by courtesy of Acme Apparatus Co.*

Radio Set Owner's Information

RE-ACTIVATING 199 TUBES AT HOME

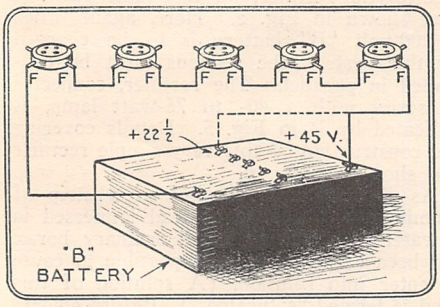
11. J. Elliot Warner of Roselle, N. J., asks:

Q. In March replying to a question of Mr. Green of Baton Rouge, you said that tubes can be re-activated at small cost by almost any dealer. I have heard that with 199 tubes this can be done at home by almost anyone. Can you tell me what the method is?

A. It is best to have tubes re-activated by a competent radio electrician whenever possible. It may be done at home, however, by observing the following directions very carefully.

Take five vacuum tube sockets and connect the filament posts together in the manner (series) shown in the accompanying drawing. Be sure to follow this method accurately, as any other connection is almost sure to burn out the tubes instead of repairing them.

Connect the end terminals of the outside sockets to a 45-volt "B" battery, as shown.



By using this method of reactivation, old tubes can be renewed for awhile.

It makes no difference to which ends the plus and minus terminals are connected; either way will do. Be sure, however, that the "B" battery has a 22½-volt tap in the middle.

Insert one tube in any of the sockets. It should not light; if it does, there is a faulty connection. It will probably flash up brilliantly and burn out if this is the case. But if nothing happens, when the first tube is inserted, the connections are probably correct and the rest of the tubes may be inserted. The moment the last one is in the socket note the time on the second hand of a watch. Let the tubes burn for half a minute at the full voltage of the battery. Then remove the lead from either terminal of the B-battery and connect it to the center tap. Leave the other lead where it was. The tubes should continue burning less brilliantly. Let them burn in this manner for an even ten minutes. Then replace them in the set.

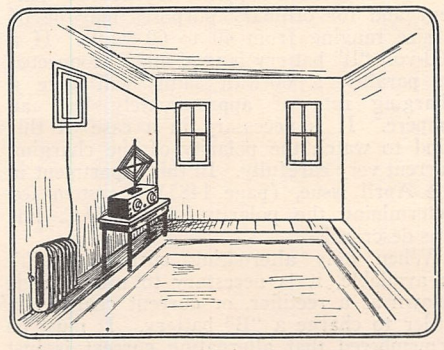
This method cannot be used with 201-A tubes because they draw too much current and would ruin the battery. It would be less expensive to have it done at the usual price by a dealer.

INCREASED RANGE ON A LOOP SET

12. J. R. Beecroft of Pelham Manor, N. Y., writes:

Q. I have a super-heterodyne using a loop antenna, and with it get reliably stations, up to 1,000 miles away, on the loudspeaker. Is there any method by which I can use an outside aerial to increase the range of my set without changing the wiring to the loop, which is all inside the set?

A. The simplest way to do it is to couple the outside antenna to the loop electromagnetically; instead of trying to connect it directly, which may upset the balance of the circuit. If the set is located against the wall, this may be accomplished by bringing the lead-in to the room in the usual manner, and making three or four turns, about three feet square as shown in the diagram, directly behind the loop. Then continue the wire to the ground by connection with a water pipe. The ground connection may be made to a radiator, if your house is heated by hot water. This method may be used as well if you have steam heat, but it is best to connect to a water pipe of some kind. The turns of wire may be concealed by hanging a picture or curtain in front of them, as this will affect the coupling to only a slight degree.



The range of a loop receiver is extended by forming a second loop of the lead-in from an outside antenna, which is inductively coupled to the set when the two loops are parallel and fairly close.

It will be found, using this system, that signals from almost all directions will come in loudest when the loop on the set is parallel to the loop on the wall. Interference may be lessened by setting the loop in the set at an angle to that on the wall. When the two are at right angles the effect of the outside antenna will be at a minimum. When it is desirable to retain the old directional effect of the loop, to cut out unwanted stations, the receiver may be placed on another table at a distance of ten or fifteen feet.

THIS page constitutes what is to be known as the SET OWNERS' INFORMATION department, and is to be conducted regularly each month in RADIO NEWS. The purpose of the department is to furnish assistance to those readers who have not yet acquired any extensive knowledge of radio, but who are the possessors of radio receivers and wish to know how to handle them.

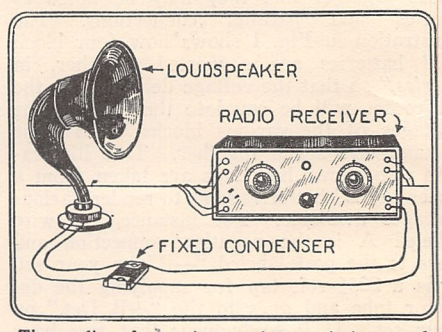
There is always new blood coming into the fraternity of radio enthusiasts; and it is obviously unreasonable to expect that they can intelligently read the articles which are written for the more experienced fans. Consequently this new department has been started for their benefit; and we invite anyone who desires to do so, to write an account of his troubles to the editor of this department. No letters will be answered by mail. The editor will select from the letters which he receives those queries that seem to be of most practical interest to all, and will answer them fully and in detail each month. There will be no charge for this service. Simply write to SET OWNERS' INFORMATION DEPARTMENT, RADIO NEWS, 53 Park Place, New York City.

COMPARATIVE COST OF "B" ELIMINATORS

13. W. Oscar Walsh of New York City asks:

Q. When does a "B" eliminator begin to save money? Is it more economical than batteries, all things considered? For example, over a two-year period, what would be the comparative cost, including all features of upkeep in each case, of the two methods of obtaining plate voltage for a five-tube set, assuming an initial cost of $50 for the "B" eliminator?

A. The average "B" eliminator draws about 15 cents worth of current per month. Its total cost of upkeep in two years would be $3.60. This makes the cost over a period of two years $53.60.



The quality of reception can be greatly improved by placing a fixed condenser in parallel with the loud speaker, as shown.

The average owner of the same type of set finds it necessary to install new batteries about once in five weeks. The replacement cost for 90 volts averages about $6.00. Thus the price of B batteries at this rate would run well over one hundred dollars. It is apparent, therefore, that the average "B" eliminator will pay for itself in about a year; and within two years will have reduced plate voltage expense 50% for the whole period. Thereafter the cost is the negligible amount on each month's electric light bill.

REMOVING THE RATTLE FROM A LOUD SPEAKER

14. R. F. A. Hollowell of Chaison, Michigan, asks:

Q. I have a loud speaker which gives good reproduction on almost all stations received; but occasionally, when one is coming in louder than usual, the loud speaker rattles on some of the notes. This seems to happen only when the music of certain instruments comes in, as when a symphony is being received. Most of the music comes in well, but occasionally there is a rattle, for no particular reason. I am sure that the diaphragm is tight and that everything is solid in the mechanism. Can this be remedied?

A. Your trouble may have several causes. Perhaps an occasional note much louder than the rest strains the speaker beyond its normal capacity for reproduction. Or it may be that an occasional note strikes one of the fundamental frequencies at which the horn vibrates of itself.

In either case it is possible to improve the output by connecting a fixed condenser across the terminals of the speaker in the manner shown in the drawing. The proper size or capacitance of this condenser depends upon the characteristics of the particular horn you use. One of about .006 microfarads should prove right for the average horn. If it does not help, try other sizes until the best results are obtained. It may be necessary to use one as large as .05 microfarads if the horn rattles badly.

Problems of a Radio Program Director

By CHAS. D. ISAACSON, Program Director, WRNY

HELENE KOSTER Mezzo - Soprano, who appears at WRNY in the Light Opera Periods.

VICTOR WITTGENSTEIN Well-known Pianist, who gave a recital over WRNY in advance of his new tour.

ISABELLE AUSTIN Formerly of Roxy's Capitol Theatre Ensemble, who appears often at WRNY.

NORMAN SECON Concert Pianist, who is a regular feature on WRNY programs.

SYLVIA RITTENBERG Young debutante singer who is frequently heard over WRNY.

CAV. A. SEISMIT DODA Famous vocal master and composer, who directs members of his studio in WRNY programs.

MARJORIE STUART Who appears with a program of Oriental songs at WRNY on alternate Fridays.

RICHARD HAGEMAN One of the greatest of American opera conductors, who directs a musical period at WRNY.

I WONDER if you folks who listen to the radio ever think about the program director—what he is trying to do? And what are some of his problems and handicaps and advantages?

The program director must sense instinctively what you listeners want to hear, and something more than that too, perhaps: what you should hear, what is good for you to hear, and what other people want to hear, who are right next door to you, and tuning in at the same time as you are.

Every station is governed by certain limitations. For instance, a program director in a little town can use only the available material. But in New York City, which is the gathering-place of the great in music, the stage, literature, arts, and every walk of life—they are all here. Take them if you can get them, but who, what, when, how?

Some program directors, very naturally and logically, turn entirely to jazz entertainment. That is all that they think of, that is all that they want, that is all that they try to bring to the listeners—and they have listeners a-plenty. But some program directors—and the writer of these articles is one of them, feel that the public wants something more than the utterly jazz type of entertainment, at least part of the time. In fact, over at WRNY, we are strongly of the opinion that the kind of people we would like to reach and please, want their diet of entertainment so balanced that jazz and the purely frivolous occupy only a minor part of the menu.

THE EASIEST WAY—AND THE OTHER

There is very little for the program director to do in putting on a jazz program. There is dance music, popular singers, some more dance music, another group of popular singers, and there it is! One thing is as good as another, all things being equal, and you turn the wheel and grind it out like a string of hamburger steak. But the moment that the program director seeks to vary his program, to supply a rounded-out bill, then come his problems.

How far can he go in seeking concert music, how high a standard may he set, how

(*Continued on page* 1608)

THE UNION CITY FOUR This banjo and mandolin ensemble is heard frequently from WRNY in medleys of popular songs—especially in the DX hours for our distant friends who listen in late.

H. O. OSGOOD The voice of "Musical Courier Says —" who is heard twice a week over WRNY in interesting talks.

JUDITH ROTH One of the finest of the regular singers over the microphone of whom we know, a WRNY feature.

HERBERT SOMAN Conductor of the Orlando Roosevelt Concert Orchestra, which you hear three times a week over WRNY.

MAUDE MORGAN Who has appeared before nearly all Europe's royalty in half a century on the concert stage.

GORDON HAMPSON Pianist and Composer, who conducts a light opera series at WRNY.

BETTY LANG Singer of popular songs to her own accompaniment, a regular WRNY number.

GRETA MASSON American Soprano, a great success at WRNY, will be heard again in Sunday night concerts.

LOUIS RICHLING A baritone of many concert engagements, who is heard regularly over WRNY.

Mass Production for the Radio Masses

By JOHN R. LOOFBOUROW*

One of the most interesting phases of any object is "how it is made." In this article is related how radio receivers are manufactured by the thousands in one of the largest factories in the United States.

PROBABLY the increasingly high standard of living, among people in general, is due to quantity production methods, which enable the manufacture of elaborate products at moderate prices, more than to any one other factor. In the early days of the automobile, only the most wealthy could afford them, because each little part of which they were made was carefully fashioned by hand. Now quantity production, in such factories as that of Ford, makes it possible to turn out a standard high quality product at a very low price, within the reach of almost every workingman. With many other products there has been a similar history—manufacturing on a big scale has brought them within the means of the man with a moderate income.

Back in 1920, when radio was still in the hand-made stage, comparable to automobiles of twenty years ago, an experiment was started in Cincinnati, Ohio, in adapting methods of quantity factory production to radio sets. The purpose in view was to sell radio sets at prices suited to the man of small means. The demand for sets exceeded all expectations, and the little plant outgrew its quarters. Another building was acquired; then another, and another, until finally there were three distinct factory units, and a printing plant.

DIVISION OF LABOR

When the experiment was started, factory radios were assembled in much the same way that the experimenter builds sets in his home. From the first details to the finished product, every operation on any particular set was done by one worker. This worker started with the parts and labored for hours until he produced the finished set. The first problem of the Cincinnati experiment was to adapt mass production methods to radio assembly, subdividing the complete job into small units, such that each worker had a certain specialized task to perform. This necessitated making sets by hundreds and thousands instead of by dozens, and it was a great question whether or not a market could be found in those days for so many sets. But a few months proved that the public wanted sets at prices all could afford, and the market proved to be much larger than the ability to supply the demand.

Let us see how this mass production of radio sets is applied today. As an example, let us follow the sub-panel of a receiver. This is a strip of insulating material with holes in it, for mounting the parts, and for receptacles for the tubes. The sub-panels are cut to size by automatic machinery. Then the holes are all punched in them in one operation, (instead of being drilled one at a time as was done a few years ago).

Next they pass on to the lettering press, shown in Fig. 1. The panels are slipped, one at a time, between the press jaws. The handle of the press is pulled down, and a die containing the lettering for marking the terminal posts is forced into the panel material, causing a white, chalky substance from the roll of impression paper to be inlaid in the panel. When the handle is released the panel strip is removed, every terminal post hole being marked with appropriate white letters. This is a great improvement over the former slow process of engraving each letter, one at a time, and then filling these in with white.

Fig. 8, above, shows the interior of one of the all-metal testing booths.

Next the sub-panel passes on to a riveting machine, where the socket contacts are riveted to it (Fig. 2). By riveting the socket contacts to the sub-panel instead of attaching them by bolts, the process of manufacture is considerably speeded up, and construction is made more foolproof. Bolts often become loose after a set has been in service for some time, while rivets will stay tight indefinitely.

FORD TYPE OF ASSEMBLY

From this point, the sub-panel starts its journey down one of the long assembly tables. Fig. 3 shows a table upon which one of the older models of sets is being assembled. Each girl along the table is given a certain operation to perform on the set as it passes by. These operations are carefully timed so that each takes about two minutes. When the sub-panel reaches the end of the table it is a complete set.

In Fig. 3 we see the sub-panels as they start their journey along the tables. Here the socket contacts are plainly visible. The first girl does nothing but screw the terminal posts into the panels and attach a few clamping brackets. This done she passes it on to the next girl, who adds a few more parts and passes it along again.

Fig. 4 shows the panel after it has progressed for some distance down the table. Already several of the wires and parts have been attached. Here the coils are being mounted. From this point on the partly-finished sets must be handled with the utmost care in order to protect the delicate parts.

PROBLEMS OF SOLDERING

One of the numerous soldering operations is shown in the next picture (Fig. 5). Soldering makes up the major portion of the work of assembly of radio sets. There are a great many wires to be soldered and one of the biggest problems is to so design the set that the wires can all be attached in regular order, one after another, with no difficulty from getting into places hard of access. Each girl is given three or four wires to solder, as it is found that soldering from six to eight joints takes about two minutes.

Soldering must be done with great care, as one badly soldered joint may cause a set to perform poorly. To help insure that all connections are of the best, many of the wires have lugs soldered to them before they are sent to the assembly tables. Other wires must be soldered directly to parts of the set, such as to socket contacts, condensers, etc. Every soldered joint is carefully inspected before the sets are packed.

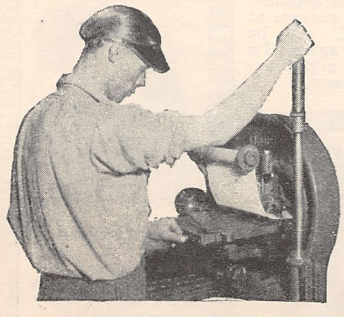


Fig. 1

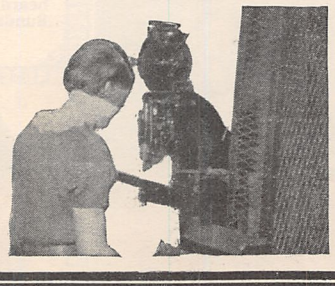


Fig. 2

Fig. 3

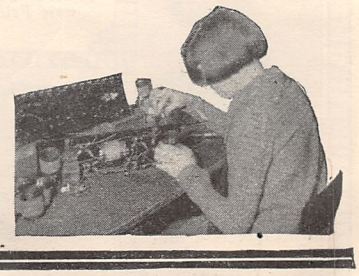


Fig. 4

*Crosley Radio Corporation

The assembly tables are provided with electric outlets every few feet along their length, so that a soldering iron may be plugged in whenever it is needed. Thus it is possible to change quickly from the assembly of one type of set to another.

PROCEDURE OF TESTING

A few steps further along we see the parts completely assembled on the sub-panel (Fig. 6) and the sub-panel ready to attach to the front panel of the set. After this has been done the unit is passed on down the line, the condensers are added, and a few more wires connected. Finally the knobs and pointers are attached to the front of the panel, and the set is passed on to the first test girl (Fig. 7), who tunes it to a special small transmitting station located in the plant, and measures the volume of signal output on a meter. The ear is no longer trusted as a safe test of performance. Nowadays each set must deliver a certain amount of measured power, as indicated by calibrated meters connected to its output.

SHIELDING THE TESTERS

Even testing is subdivided into several operations, in order that the set need never stay at one point in its progress for more than two minutes. After leaving the first test girl, the set is mounted in a cabinet, and slid through a little window into a metal-shielded test booth (Fig. 8). These booths are like little tin houses, built completely of metal, so as to shield the operators inside from all extraneous electrical disturbances. The operator who receives the set places it in a special rack that automatically makes all battery connections. Then she "balances" it so that it will not squeal at any wavelength, (while at the same time maintaining maximum amplification). When she has completed her part of the job, she passes the set on to another girl in the booth, who thoroughly inspects the set and tests it to see that the balancing has been done properly, and that the set has been properly checked for volume of signal output. Thence it passes on to the packer who places it in its carton, and from there it goes to the shipping room.

Thus every two minutes a sub-panel starts its journey down the tables, and every two minutes a tested and packed set is delivered at the other end.

In a working day of eight hours, each table has an output of 200 to 250 sets. During peak periods, the total production of the assembly plants has reached 6,000 to 8,000 sets a day. Just think of this: Seven or eight years ago it would have been considered phenomenal to manufacture that many radio sets in a year!

COIL-WINDING MACHINERY

The parts that go into the construction of sets are made and assembled in much this same manner. Each operator is assigned a unit task, though of course much of the work of parts manufacture is done by automatic machinery. The coil winding machine shown in Fig. 9, for instance, automatically winds the proper number of turns, and then stops until the coil is removed and a new form mounted on the chuck.

How automatic machinery has replaced hand processes is shown again in Fig. 10, where coils that have been baked, (removing all moisture from them) are being soaked in paraffin, to make them impervious to weather conditions. Formerly the coils were dipped in paraffin by hand and then swung violently back and forth to remove all excess paraffin from them. In this machine, they are placed on a rack which carries them through the hot molten wax, and then passes them under a rapidly vibrating series of compressed air nozzles, which remove all excess paraffin. Thus uniform coating is received.

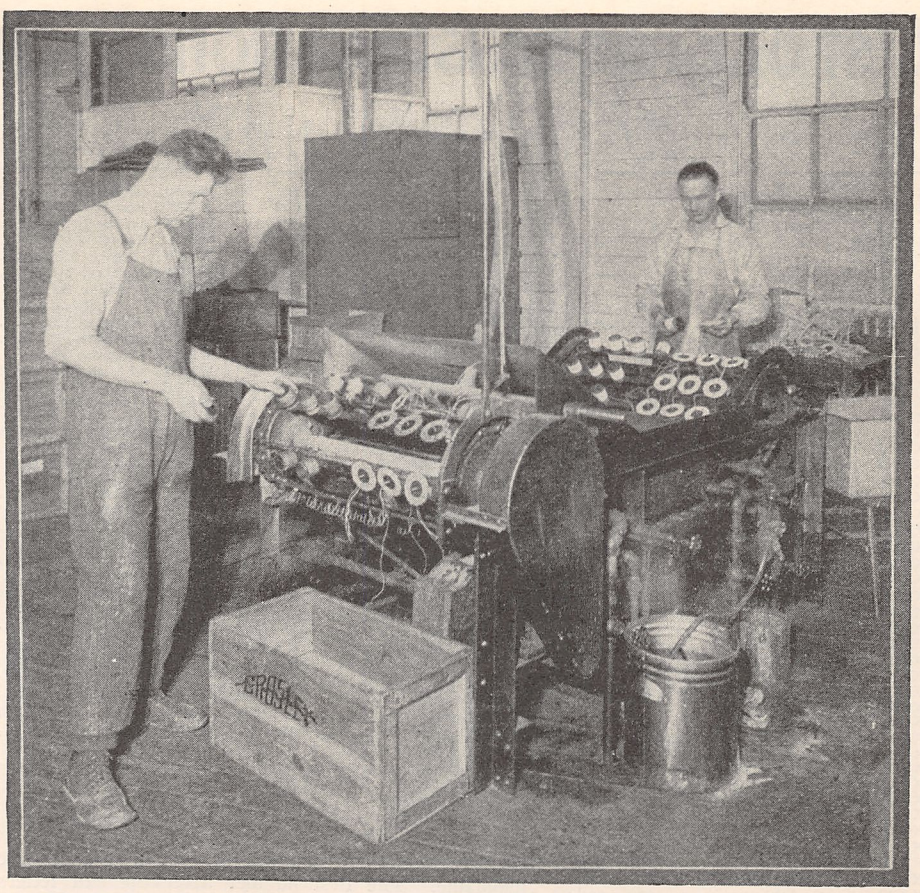


Fig. 10 shows how inductance coils are soaked in paraffin, in order to render them impervious to weather conditions.
Photos by courtesy of Crosley Radio Corp.

One of the important advantages of the use of automatic machinery and of unit assembly system is that a uniformity of product is assured. When parts were made and sets put together laboriously by hand, there was a great degree of variation in the finished article, as so much depended upon the particular worker who did the job. By specializing small unit tasks and training each worker to be highly skilled at her particular job, uniformity is assured, and it is made certain that each set delivered will measure up to a rigid standard of perfection.

VALUE OF WOMEN WORKERS

Visitors are often impressed by the fact that practically all of the workers in these plants are girls or women. "Why don't you use men for this assembly work?" they ask those in charge. The answer, it seems, is that girls are more reliable than men for performing the unit operations of assembly. While men are unexcelled for work involving the operation of machines of a complicated nature, they cannot be relied upon as much as can women for performing simple tasks with a high degree of speed and accuracy.

The story is well known, how one manufacturer's determination to produce radio sets at a price within the reach of all had its inspiration six years ago, when he was asked $130 for a one-tube set he wished to purchase for his son. By simplification of parts and efficiencies in factory methods, he and others have been able to reduce the cost of radio receivers again and again; until a one-tube set can now be bought at retail for as little as $9.75. Many of the sets on the market today cost less than the simple accessories necessary to operate them.

While this development of system in design and efficiency in manufacture has resulted in quality production at prices suited to the pocketbooks of Mr. and Mrs. Average Citizen, the latter by sheer numbers and mass buying power have insured the permanence of another great industry among the sources of national and individual prosperity. Better standards of living, with the employment to which they give rise, may correctly be termed "regenerative" in their effect upon business and the great body of consumers. With nearly thirty million prospects for moderate and low-priced radio outfits, and the certainty of great improvements in the science and increase in the population, radio production and sales will be kept at increasingly enormous figures for many years.

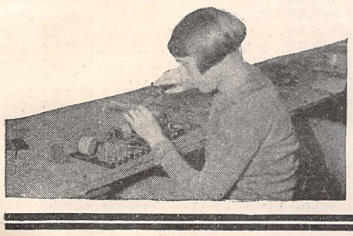


FIG. 5

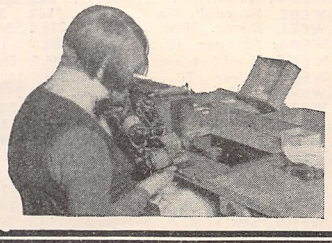


FIG. 6

FIG. 7

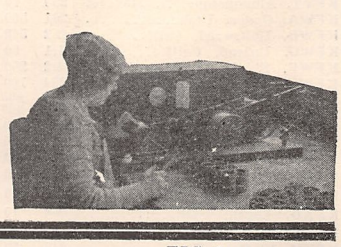


FIG. 9

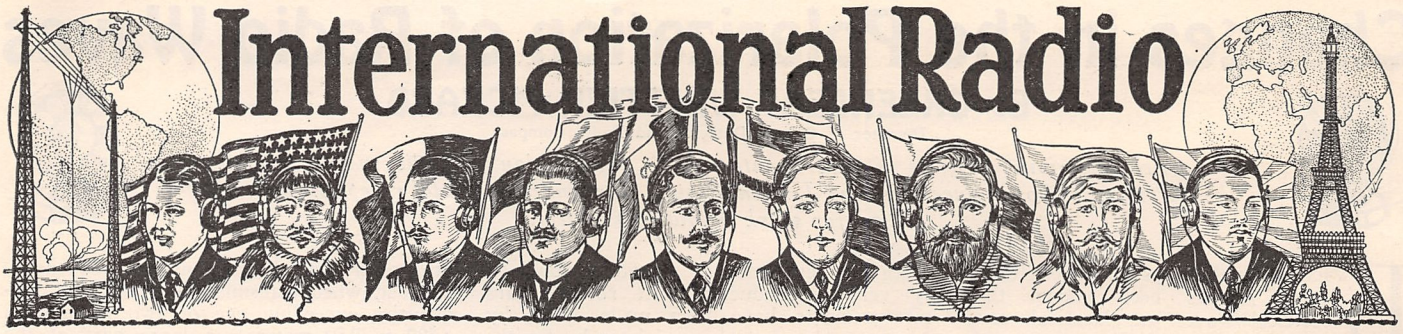
List of Broadcast Stations in the United States

Radio Call Letter	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KDKA,	East Pittsburgh, Pa.	309.1	Var.
KDLR,	Devils Lake, N. D.	231	5
KDYL,	Salt Lake City, Utah	246	50
KDZB,	Bakersfield, Calif.	209.7	100
KFAB,	Lincoln, Neb.	340.7	1000
KFAD,	Phoenix, Ariz.	273	100
KFAF,	San Jose, Calif.	217.3	50
KFAJ,	Boulder, Colo.	261	100
KFAU,	Boise, Idaho	280.2	750
KFBB,	Havre, Mont.	275	50
KFBC,	San Diego, Calif.	215.7	10
KFBK,	Sacramento, Calif.	248	100
KFBL,	Everett, Wash.	224	100
KFBS,	Trinidad, Colo.	238	15
KFBU,	Laramie, Wyo.	270	500
KFCB,	Phoenix, Ariz.	238	100
KFDD,	Boise, Idaho	278	50
KFDM,	Beaumont, Tex.	315.6	500
KFDX,	Shreveport, La.	250	100
KFDY,	Brookings, S. Dak.	273	100
KFDZ,	Minneapolis, Minn.	231	10
KFEC,	Portland, Ore.	248	50
KFEL,	Denver, Colo.	254	50
KFEQ,	Oak, Nebr.	268	500
KFEY,	Kellogg, Idaho	233	10
KFFP,	Moberly, Mo.	242	50
KFGQ,	Boone, Iowa	226	10
KFH,	Wichita, Kans.	268	500
KFHA,	Gunnison, Colo.	252	50
KFHL,	Oskaloosa, Iowa	240	10
KFI,	Los Angeles, Calif.	468.5	4000
KFIF,	Portland, Ore.	248	100
KFIO,	Spokane, Washington	265.3	100
KFIQ,	Yakima, Wash.	256	100
KFIU,	Juneau, Alaska	226	10
KFIZ,	Fond du Lac, Wis.	273	100
KFJB,	Marshalltown, Iowa	218	10
KFJC,	Junction City, Kansas	218.8	10
KFJF,	Oklahoma City, Okla.	261	500
KFJI,	Astoria, Ore.	246	10
KFJM,	Grand Forks, N. Dak.	278	100
KFJR,	Portland, Ore.	263	50
KFJY,	Fort Dodge, Iowa	246	50
KFJZ,	Fort Worth, Tex.	254	50
KFKA,	Greeley, Colo.	273	50
KFKU,	Lawrence, Kans.	275	500
KFKX,	Hastings, Nebr.	288.3	5000
KFKZ,	Kirksville, Mo.	266	10
KFLR,	Albuquerque, N. Mex.	254	100
KFLU,	San Benito, Tex.	236	10
KFLV,	Rockford, Ill.	229	100
KFLX,	Galveston, Tex.	240	10
KFLZ,	Anita, Iowa	273	100
KFMQ,	Fayetteville, Ark.	299.8	750
KFMR,	Sioux City, Iowa	261	100
KFMW,	Houghton, Mich.	263	50
KFMX,	Northfield, Minn.	336.9	500
KFNF,	Shenandoah, Iowa	263	500
KFOA,	Seattle, Wash.	454.3	1000
KFOB,	Burlingame, Calif.	226	50
KFON,	Long Beach, Calif.	233	500
KFOO,	Salt Lake City, Utah	236	250
KFOR,	David City, Nebr.	226	100
KFOT,	Wichita, Kans.	231	50
KFOX,	Omaha, Nebr.	248	100
KFOY,	St. Paul, Minn.	252	50
KFPL,	Dublin, Texas	252	15
KFPM,	Greenville, Texas	242	10
KFPR,	Los Angeles, Calif.	230.6	500
KFPW,	Carterville, Mo.	258	20
KFPY,	Spokane, Wash.	266	100
KFQA,	St. Louis, Mo.	261	100
KFQB,	Fort Worth, Texas	263	1000
KFQD,	Anchorage, Alaska	227.1	100
KFQP,	Iowa City, Iowa	224	10
KFQU,	Alma (Holy City) Calif.	217.3	100
KFQW,	North Bend, Wash.	215.7	50
KFQZ,	Hollywood, Calif.	225.4	50
KFRB,	Beeville, Tex.	248	250
KFRC,	San Francisco, Calif.	268	50
KFRU,	Columbus, Mo.	499.7	500
KFRW,	Olympia, Wash.	218.8	50
KFSG,	Los Angeles, Calif.	275	500
KFUL,	Galveston, Tex.	258	50
KFUO,	St. Louis, Mo.	545.1	500
KFUP,	Denver, Colo.	234	50
KFUR,	Ogden, Utah	224	50
KFUS,	Oakland, Calif.	256	50
KFUT,	Salt Lake City, Utah	261	100
KFUU,	Oakland, Calif.	220	50
KFVD,	San Pedro, Calif.	205.4	50
KFVE,	St. Louis, Mo.	240	500
KFVG,	Independence, Mo.	236	15
KFVH,	Manhattan, Kansas	218.8	15
KFVI,	Houston, Texas	240	10
KFVN,	Welcome, Minn.	227	50
KFVR,	Denver, Colo.	244	50
KFVS,	Cape Girardeau, Mo.	224	50
KFVW,	San Diego, Calif.	246	500
KFVY,	Albuquerque, N. Mex.	250	10
KFWA,	Ogden, Utah	261	500
KFWB,	Hollywood, Calif.	252	500
KFWC,	Upland, Calif.	211.1	50
KFWF,	St. Louis, Mo.	214.2	250
KFWH,	Chico, Calif.	254	100
KFWI,	So. San Francisco, Calif.	226	500
KFWM,	Oakland, Calif.	206.8	500
KFWO,	Avalon, Calif.	211.1	250
KFWU,	Pineville, La.	238	100
KFWV,	Portland, Ore.	212.6	50
KFXB,	Big Bear Lake, Calif.	202.6	500
KFXC,	Santa Maria, Calif.	209.7	100
KFXD,	Logan, Utah	205.4	10
KFXF,	Colorado Springs, Colo.	250	500
KFXH,	El Paso, Texas	242	50
KFXJ,	Denver, Colo.	215.7	10
KFXM,	Beaumont, Texas	227	10
KFXR,	Oklahoma City, Okla.	214.2	15
KFXY,	Flagstaff, Ariz.	205.4	50
KFYF,	Oxnard, Calif.	205.4	10
KFYJ,	Houston, Texas	238	10
KFYO,	Texarkana, Tex.	209.7	10
KFYR,	Bismarck, N. Dak.	248	10
KGO,	Oakland, Calif.	361.2	4000
KGTT,	San Francisco, Calif.	206.8	50
KGU,	Honolulu, Hawaii	270	500
KGW,	Portland, Ore.	491.5	500
KGY,	Lacey, Wash.	246	50
KHJ,	Los Angeles, Calif.	405.2	500
KHQ,	Spokane, Wash.	273	500
KJBS,	San Francisco, Calif.	220	5
KJR,	Seattle, Wash.	384.4	1000
KLDS,	Independence, Mo.	440.9	1000
KLS,	Oakland, Calif.	250	250
KLX,	Oakland, Calif.	508.2	500
KLZ,	Denver, Colo.	266	250
KMA,	Shenandoah, Iowa	252	500
KMJ,	Fresno, Calif.	234	50
KMMJ,	Clay Center, Neb.	228.9	1000
KMO,	Tacoma, Wash.	250	100
KMOX,	Kirkwood, (St. Lo), Mo.	280.2	1500
KMTR,	Los Angeles, Calif.	238	500
KNRC,	Los Angeles, Calif.	208.2	250
KNX,	Los Angeles, Calif.	336.9	1000
KOA,	Denver, Colo.	322.4	5000
KOAC,	Corvallis, Ore.	280.2	500
KOB,	State College, N. M.	348.6	1000
KOCH,	Omaha, Neb.	258	250
KOCW,	Chickasha, Okla.	252	200
KOIL,	Council Bluffs, Iowa	278	500
KOWW,	Walla Walla, Wash.	256	500
KPO,	San Francisco, Calif.	428.3	1000
KPPC,	Pasadena, Calif.	229	50
KPRC,	Houston, Texas	296.9	500
KPSN,	Pasadena, Calif.	315.6	1000
KQP,	Portland, Ore.	212.6	500
KQV,	Pittsburgh, Pa.	275	500
KQW,	San Jose, Calif.	231	500
KRE,	Berkeley, Calif.	256	100
KSAC,	Manhattan, Kansas	340.7	500
KSD,	St. Louis, Mo.	545.1	500
KSL,	Salt Lake City, Utah	299.8	1000
KSO,	Clarinda, Iowa	242	500
KTAB,	Oakland, Calif.	240	1000
KTBI,	Los Angeles, Calif.	293.9	750
KTBR,	Portland, Ore	263	50
KTCL,	Seattle, Wash.	305.9	1000
KTHS,	Hot Springs, Ark.	374.8	500
KTNT,	Muscatine, Iowa	256	500
KTW,	Seattle, Wash.	454.3	1000
KUO,	San Francisco, Calif.	250	150
KUOM,	Missoula, Mont.	244	250
KUSD,	Vermillion, S. D.	278	100
KUT,	Austin, Texas	231	500
KVOO,	Bristow, Okla.	374.8	500
KWCR,	Cedar Rapids, Iowa	278	500
KWG,	Stockton, Calif.	248	50
KWKC,	Kansas City, Mo.	236	100
KWKH,	Kennonwood, La.	261	500
KWSC,	Pullman, Wash.	348.6	500
KWWG,	Brownsville, Texas	278	500
KYW,	Chicago, Ill.	535.4	3500
KZIB,	Manila, P. I.	249.9	20
KZKZ,	Manila, P. I.	270	100
KZM,	Oakland, Calif.	240	100
KZRQ,	Manila, P. I.	222	500
KZUY,	Baguio, P. I.	360	500
NAA,	Arlington, Va.	434.5	1000
WAAD,	Cincinnati, Ohio	258	25
WAAF,	Chicago, Ill.	278	200
WAAW,	Omaha, Neb.	278	500
WABB,	Harrisburg, Pa.	204	10
WABC,	Asheville, N. C.	254	20
WABI,	Bangor, Me.	240	100
WABO,	Rochester, N. Y.	278	100
WABQ,	Haverford, Pa.	261	100
WABR,	Toledo, Ohio	263	50
WABW,	Wooster, Ohio	206.8	50
WABX,	Mount Clemens, Mich.	246	500
WABY,	Philadelphia, Pa.	242	50
WABZ,	New Orleans, La.	275	50
WADC,	Akron, Ohio	258	500
WAFD,	Port Huron, Mich.	275	500
WAGM,	Royal Oak, Mich.	225.4	50
WAHG,	Richmond Hill, N. Y.	315.6	500
WAIT,	Taunton, Mass.	229	10
WAIU,	Columbus, Ohio	293.9	500
WAMD,	Minneapolis, Minn.	244	500
WAPI,	Auburn, Ala.	248	500
WARC,	Medford Hillside, Mass.	261	100
WATT,	Boston, Mass.	245.8	100
WBAA,	West Lafayette, Ind.	273	250
WBAK,	Harrisburg, Pa.	275	500
WBAL,	Baltimore, Md.	246	5000
WBAO,	Decatur, Ill.	270	100
WBAP,	Fort Worth, Texas	475.9	1500
WBAX,	Wilkes-Barre, Pa.	256	100
WBBL,	Richmond, Va.	229	100
WBBM,	Chicago, Ill.	226	1500
WBBP,	Petoskey, Mich.	238	200
WBBR,	Rossville, N. Y.	273	500
WBBS,	New Orleans, La.	252	50
WBBW,	Norfolk, Va.	222	50
WBBY,	Charleston, S. C.	268	10
WBBZ,	Chicago, Ill.	215.7	50
WBCN,	Chicago, Ill.	266	500
WBDC,	Grand Rapids, Mich.	256	500
WBES,	Takoma Park, Md.	222	100
WBNY,	New York, N. Y.	209.7	500
WBOQ,	Richmond Hill, N. Y.	236	100
WBPI,	Newark, N. J.	263	500
WBRC,	Birmingham, Ala.	248	50
WBRE,	Wilkes-Barre, Pa.	231	100
WBT,	Charlotte, N. C.	275	250
WBZ,	Springfield, Mass.	331.1	2000
WBZA,	Boston, Mass.	242	250
WCAC,	Mansfield, Conn.	275	500
WCAD,	Canton, N. Y.	263	250
WCAE,	Pittsburgh, Pa.	461.3	500
WCAJ,	University Place, Neb.	254	500
WCAL,	Northfield, Minn.	336.9	500
WCAO,	Baltimore, Md.	275	100
WCAP,	Washington, D. C.	468.5	500
WCAR,	San Antonio, Texas	263	500
WCAT,	Rapid City, S. D.	240	50
WCAU,	Philadelphia, Pa.	278	500
WCAX,	Burlington, Vt.	250	100
WCBA,	Allentown, Pa.	254	15
WCBD,	Zion, Ill	344.6	5000
WCBE,	New Orleans, La.	263	5
WCBH,	Oxford, Miss.	242	50
WCBM,	Baltimore, Md.	229	50
WCBQ,	Nashville, Tenn.	236	100
WCBR,	Providence, R. I.	205.4	30
WCCO,	Minneapolis, Minn.	416.4	5000
WCEE,	Elgin, Ill.	275	1000
WCLO,	Camp Lake, Wis.	231	50
WCLS,	Joliet, Ill.	214.2	150
WCSH,	Portland, Me.	256	500
WCSO,	Springfield, Ohio	248	100
WCWS,	Providence, R. I.	209.7	100
WCX,	Pontiac, Mich.	516.9	5000
WDAD,	Nashville, Tenn.	226	150
WDAE,	Tampa, Fla.	273	250
WDAF,	Kansas City, Mo.	365.6	500
WDAG,	Amarillo, Texas	263	100
WDAH,	El Paso, Tex.	267.7	50
WDAY,	Fargo, N. D.	261	50
WDBC,	Lancaster, Pa.	258	50
WDBE,	Atlanta, Ga.	270	100
WDBJ,	Roanoke, Va.	229	50
WDBK,	Cleveland, Ohio	227	100
WDBO,	Winter Park, Fla.	240	500
WDBZ,	Kingston, N. Y.	233	10
WDOD,	Chattanooga, Tenn.	256	500
WDRC,	New Haven, Conn.	268	100
WDWF,	Cranston, R. I.	440.9	500
WDZ,	Tuscola, Ill.	278	10-100
WEAF,	New York, N. Y.	491.5	5000
WEAI,	Ithaca, N. Y.	254	500
WEAM,	North Plainfield, N. J.	261	250
WEAN,	Providence, R. I.	270	500
WEAO,	Columbus, Ohio	293.9	500
WEAR,	Cleveland, Ohio	389.4	750
WEAU,	Sioux City, Iowa	275	100
WEBC,	Superior, Wis.	242	100
WEBD,	Anderson, Ind.	246	15
WEBE,	Cambridge, Ohio	234	10
WEBH,	Chicago, Ill.	370.2	1500
WEBJ,	New York, N. Y.	273	500
WEBL,	New York, N. Y.	226	100
WEBM,	New York, N. Y.	226	100
WEBQ,	Harrisburg, Ill.	226	10
WEBR,	Buffalo, N. Y.	244	100
WEBW,	Beloit, Wis.	268	500
WEBZ,	Savannah, Ga.	263	50
WEEI,	Boston, Mass.	348.6	500
WEHS,	Evanston, Ill.	202.6	10
WEMC,	Berrien Springs, Mich.	285.5	500
WENR,	Chicago, Ill.	266	1000
WEW,	St. Louis, Mo.	248	1000
WFAA,	Dallas, Texas	475.9	500
WFAM,	St. Cloud, Minn.	273	10
WFAV,	Lincoln, Nebr.	275	500
WFBC,	Knoxville, Tenn.	250	50
WFBD,	Philadelphia, Pa.	234	5
WFBE,	Seymour, Ind.	226	10
WFBG,	Altoona, Pa.	278	100
WFBH,	New York, N. Y.	273	500
WFBI,	Camden, N. J.	236	250
WFBJ,	Collegeville, Minn.	236	100
WFBL,	Syracuse, N. Y.	252	100
WFBM,	Indianapolis, Indiana	268	250
WFBR,	Baltimore, Md.	254	100
WFBZ,	Galesburg, Ill.	254	20
WFDF,	Flint, Mich.	234	100
WFI,	Philadelphia, Pa.	394.5	500
WFKB,	Chicago, Ill.	217.3	500
WFRL,	Brooklyn, N. Y.	205.4	100
WGAL,	Lancaster, Pa.	248	10
WGBB,	Freeport, N. Y.	244	100
WGBC,	Memphis, Tenn.	278	10
WGBF,	Evansville, Ind.	236	500
WGBI,	Scranton, Pa.	240	10
WGBM,	Providence, R. I.	234	30
WGBR,	Marshfield, Wis.	229	10
WGBS,	New York, N. Y.	315.6	500
WGBU,	Fulford, Fla.	278	500
WGBX,	Orono, Me.	252	100
WGCP,	Newark, N. J.	252	500
WGES,	Oak Park, Ill.	250	500
WGHB,	Clearwater, Fla.	266	500
WGHP,	Detroit, Mich.	270	1500
WGMU,	Richmond Hill, N. Y.	236	100
WGN,	Chicago, Ill.	302.8	1000
WGR,	Buffalo, N. Y.	319	750
WGST,	Atlanta, Ga.	270	500
WGY,	Schenectady, N. Y.	379.5	5000
WHA,	Madison, Wis,	535.4	750
WHAD,	Milwaukee, Wis.	275	500
WHAM,	Rochester, N. Y.	278	100
WHAP,	New York, N. Y.	240	500
WHAR,	Atlantic City, N. J.	275	500
WHAS,	Louisville, Ky.	399.8	500
WHAT,	Minneapolis, Minn.	263	500
WHAV,	Wilmington, Del.	266	100
WHAZ,	Troy, N. Y.	379.5	1000
WHB,	Kansas City, Mo.	365.6	500
WHBA,	Oil City, Pa.	250	10
WHBC,	Canton, Ohio	254	10
WHBD,	Bellefontaine, Ohio	222	20
WHBF,	Rock Island, Ill.	222	100
WHBG,	Harrisburg, Pa.	231	20
WHBH,	Culver, Ind.	222	100
WHBJ,	Fort Wayne, Ind.	234	50
WHBK,	Ellsworth, Me.	231	10
WHBL,	Chicago, Ill.	215.7	50
WHBM,	Chicago, Ill.	215.7	20
WHBN,	St. Petersburg, Fla.	238	10
WHBP,	Johnstown, Pa.	256	100
WHBQ,	Memphis, Tenn.	233	50
WHBU,	Anderson, Ind.	218.8	10
WHBW,	Philadelphia, Pa.	215.7	100
WHBY,	West De Pere, Wis.	250	50
WHDI,	Minneapolis, Minn.	278	500
WHEC,	Rochester, N. Y.	258	100
WHK,	Cleveland, Ohio	272.6	1000
WHN,	New York, N. Y.	361.2	500
WHO,	Des Moines, Iowa	526	5000
WHT,	Deerfield, Ill.	238	3500
WIAD,	Philadelphia, Pa.	250	100
WIAS,	Burlington, Iowa	254	100
WIBA,	Madison, Wis.	236	100
WIBG,	Elkins Park, Pa.	222	50
WIBH,	New Bedford, Mass.	209.7	30
WIBI,	Flushing, N. Y.	218.8	50
WIBJ,	Chicago, Ill.	215.7	50
WIBM,	Chicago, Ill.	215.7	10
WIBO,	Chicago, Ill.	226	1000
WIBR,	Weirton, W. Va.	246	50
WIBS,	Elizabeth, N. J.	202.6	10
WIBU,	Poynette, Wis.	222	20
WIBW,	Logansport, Ind.	220	100
WIBX,	Utica, N. Y.	205.4	150
WIBZ,	Montgomery, Ala.	231	10
WIL,	St. Louis, Mo.	273	250
WIOD,	Miami Beach, Fla.	247.8	1000
WIP,	Philadelphia, Pa.	508.2	500
WJAD,	Waco, Texas	352.7	500
WJAG,	Norfolk, Nebr.	270	200
WJAK,	Kokomo, Ind.	254	50
WJAM,	Cedar Rapids, Iowa	268	100
WJAR,	Providence, R. I.	305.9	500
WJAS,	Pittsburgh, Pa.	275	500
WJAX,	Jacksonville, Fla.	336.9	1000
WJAZ,	Mount Prospect, Ill.	322.4	1500
WJBA,	Joliet, Ill.	206.8	50
WJBB,	St. Petersburg, Fla.	254	10
WJBC,	La Salle, Ill.	234	100
WJBG,	Charlotte, N. C.	224	10
WJBI,	Red Bank, N. J.	218.8	250
WJBK,	Ypsilanti, Mich.	233	10
WJBL,	Decatur, Ill.	270	500
WJBO,	New Orleans, La.	268	100
WJBP,	Buffalo, N. Y.	218.8	50
WJBU,	Lewisburg, Pa.	211.1	100
WJJD,	Mooseheart, Ill.	370.2	500
WJR,	Pontiac, Mich.	516.9	5000
WJY,	New York, N. Y.	405.2	1000
WJZ,	New York, N. Y.	454.3	Var.
WKAF,	Milwaukee, Wis.	261	500
WKAQ,	San Juan, P. R.	340.7	500
WKAR,	East Lansing, Mich.	285.5	1000
WKAV,	Laconia, N. H.	224	50
WKBB,	Joliet, Ill.	214.2	100
WKBE,	Webster, Mass.	231	100
WKBG,	Chicago, Ill.	215.7	100
WKRC,	Cincinnati, Ohio	325.9 & 422.3	1000
WKY,	Oklahoma City, Okla.	275	100
WLAL,	Tulsa, Okla.	250	100
WLAP,	Louisville, Ky.	275	20
WLBL,	Stevens Point, Wis.	278	500
WLIB,	Elgin, Ill.	302.8	4000
WLIT,	Philadelphia, Pa.	394.5	500
WLS,	Crete, Ill.	344.6	5000
WLSI,	Cranston, R. I.	440.9	500

The complete list of broadcast stations, arranged for convenient reference, will appear every month in RADIO NEWS, with revisions and changes up to the closing date of the magazine. The first number after the call letters of the station is the wave-length of the station, expressed in meters; and the second number its power, expressed in watts.

(Continued on page 1565)

International Radio



JAPAN

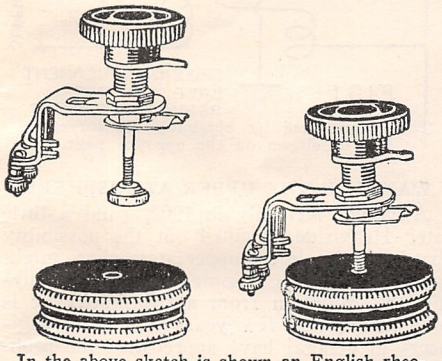
Sets Sealed in Japan

As in nearly every country other than the United States, there is required in Japan the payment of an annual license fee of about nine dollars and a half for listening in. When the license is granted to a listener his set is tuned to the wave-length of the Tokio Municipal Broadcast station and then sealed, so that no other station may be tuned in. It is reported that this is done in order that no radical ideas can be picked up if put on the air by secret broadcast stations.

GREAT BRITAIN

Transmission from Moving Train

A very interesting transmission was recently effected through a London broadcast station. There was installed on a train a 100-watt radio transmitter, with a three-wire antenna atop of the car in which the sending equipment was placed. The microphone of the transmitter was placed on the footplate of the locomotive and leads were run to the car through armoured cable. In this way all the various noises of a speeding train were put on the air.



In the above sketch is shown an English rheostat, of interest to the experimenter. The resistances are interchangeable; all that is neccssary being to unscrew a knurled nut to slip one resistance off and the other one on. It is necessary to drill but one hole in the panel for mounting purposes. By using different resistance-units, this rheostat can be used for the regulation of any type of vacuum tube.

A section of telegraph line between two stations, Potter's Bar and Hitchin, was insulated from the rest of the line. This telegraph line was used as a receiving antenna by a receiving set in between these two stations, and the signals picked up by this set were relayed to the broadcast station in London. —*N. C. McLoud.*

From An English Expert

The following letter might be of interest to radio fans of the United States, showing that the Ananias Club is an international organization:

"Editor, Popular Wireless, London:

"Dear Sir,—It may interest you to know that I have constructed a wireless receiving set consisting of one permanent crystal detector and fourteen oscillating crystal amplifiers. The whole set is run off the electric cells that actuate the front door bell, and the reception has been remarkable.

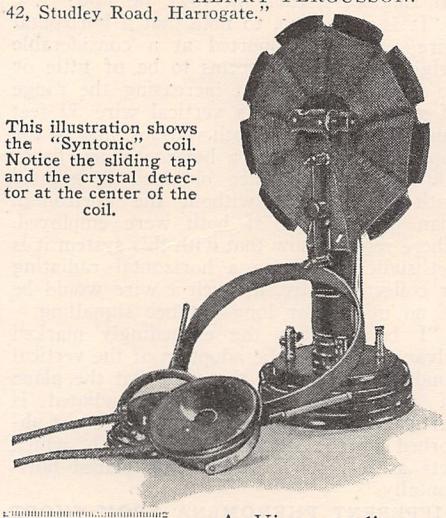
"European stations can only be endured when the loud speaker is tightly muffled in a blanket; New Zealand comes in so powerfully that a headphone laid on the sound-box of the gramophone fills the room.

"My most outstanding success, however, was obtained when accidentally tuning in an afternoon concert from Peru. The windows were shattered, and a large crowd assembled round the house, wondering and delighted at the volume of music that was apparently coming from massed bands within.

"I shall be delighted to supply you with any further particulars. Yours truly,

HENRY FERGUSSON.

42, Studley Road, Harrogate."



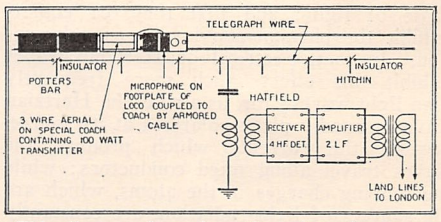
This illustration shows the "Syntonic" coil. Notice the sliding tap and the crystal detector at the center of the coil.

A 'Syntonic' Basket Coil

A Vienna radio amateur has recently patented a new device for improving reception on the usual basket or spider-web coil, in which the unemployed windings of the coil are reduced to a minimum, and a particularly pure reception plus an increased intensity of sound are gained.

The coil is the usual type, with nine radial grooves; a contact button being laid between two grooves, and moved according to the wave-length desired, as in a regular hollow-cored spiral coil, the range being between 100 and 2,000 meters.

For use with the spool, the inventor has built a special crystal set closely resembling an American or English "stand" telephone. With any good crystal, and with no other amplification, it can be used to operate a loud speaker, bringing in all local stations clearly. In distance reception it is most effective with head-phones, though in some instances a loud speaker can be used. It will operate on a frame aerial, or can be plugged into the electric light socket. —*N. C. McLoud.*



This diagram shows how the noises of a moving train were broadcast from London.

Television Experiments

The English Postmaster-General has agreed to authorize the broadcasting of pictures under the system developed by Mr. J. L. Baird of Glasgow. It is reported that the French authorities have also been asked for permission to attempt the transmission of pictures between London and Paris.

One of the exhibits at a recent radio exhibition in Tokio shows how listening-in is done in the East.

©*Wide World Photos*

Changes in the Polarization of Radio Waves

By GREENLEAF WHITTIER PICKARD
Inventor of Crystal Detector and Radio Compass

An article describing a series of experiments on the polarization of radio waves, by one of the foremost radio engineers in the United States. He finds horizontal reception most effective for work below 100 meters.

EVER since the days of Maxwell and Hertz it has been known that electrical waves are identical, save in the matter of frequency, with those of light; and that they, of course, exhibit the phenomenon known as polarization. In fact, electrical or Hertzian waves exhibit this effect much more frequently than light waves; for, as a rule, the Hertzian wave is fixedly plane-polarized at its source, because the currents which produce the waves travel along fixed conductors; while the moving charges in the atoms, which are the sources of light-radiation, are constantly changing the planes of their orbits. Natural light, as from a candle flame or from the sun, therefore appears to be non-polarized, but the radiation from a transmitting antenna, analyzed at a distance of a few wavelengths, is completely plane-polarized.

In the ordinary practice of radio communication, the currents flow between an elevated network of wires and the ground, and are substantially vertical, so that the radiation starts vertically plane-polarized. It has been assumed, from the earliest days of this art, that the waves would remain vertically polarized at all distances; and hence the best mode of reception would be by vertical conductors. In recent years measurements have been made (first by Austin in this country, and later by Smith-Rose and Barfield in England) which confirmed this assumption for the lower transmission-frequencies, that is, for the band from 10 to 700 kilocycles (30,000 to 429 meters).

Equally, it was early assumed that for best transmission the wave should be vertically plane-polarized, that is, radiated from a vertical antenna, and received on a vertical conductor. Early experiments by Marconi apparently confirmed this, and in a paper read before the Institute of Electrical Engineers, early in 1899, he said:

"It is well, also, to note that a horizontal wire, even if supported at a considerable height from earth, seems to be of little or no practical utility in increasing the range of signals. If, say, a vertical wire 30 feet long is employed at both stations, and to the top of this is added a horizontal length of 300 feet, the distance obtained is greater with the vertical without the horizontal, than it would be if both were employed. These results show that with this system it is not sufficient to use a horizontal radiating or collecting wire, as such a wire would be of no utility for long-distance signalling.

"I believe that the exceedingly marked advance made by the adoption of the vertical conductor is due to the fact that the plane of polarization of the rays radiated is vertical, and that therefore they are not absorbed by the surface of the earth, which acts as a receiving conductor placed horizontally."

THE author of this article, G. W. Pickard, is one of the best known authorities on radio in this country. He is the inventor of the crystal detector, and did considerable remarkable pioneer work in connection with this. He also invented and designed the radio compass, which is now finding such universal use in maritime radio.

In this article the author presents a bird's eye view of the polarization situation. The subject of polarization of radio waves has been popularized recently in the radio press, so that we feel sure some remarks from such an authority will be welcomed by our readers. —EDITOR.

DIFFERENT PHENOMENA FROM SHORT WAVES

It is one of the objects of this article to show that certain of the above assumptions are not true at all transmission frequencies. In fact, when transmission is made at frequencies exceeding one or two megacycles (300 to 150 meters), a large part of the wave reaches the distant receiver horizontally polarized; and, strangely enough, it makes very little difference as to this effect, whether the wave leaves the transmitter vertically or horizontally polarized. I have also found, entirely contrary to the experience at the lower frequencies, that horizontal collecting wires are of marked utility in long-distance reception of such waves.

Though in the first quarter century of practical radio communication nothing was employed but vertically plane-polarized waves, it is of more than passing interest to note that, in 1902, Allessandro Artom suggested the use of circularly-polarized beam radiation. This inventor proposed to erect two linear radiators at right angles to each other, and both at 45° with the vertical, forming a St. Andrew's cross; and by generating in these wires oscillations of the same frequency, but differing in phase by 90°, to project a beam of circularly-polarized waves. At this early date Artom did not have at his command any effective generator of continuous oscillations; and although in 1903-4 tests were made of his system in Italy, the results do not appear to have been conclusive.

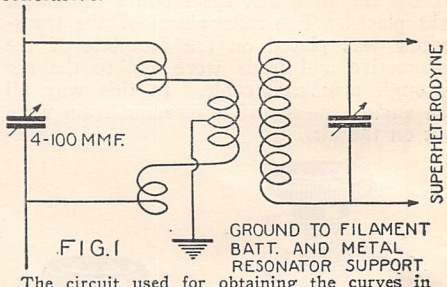
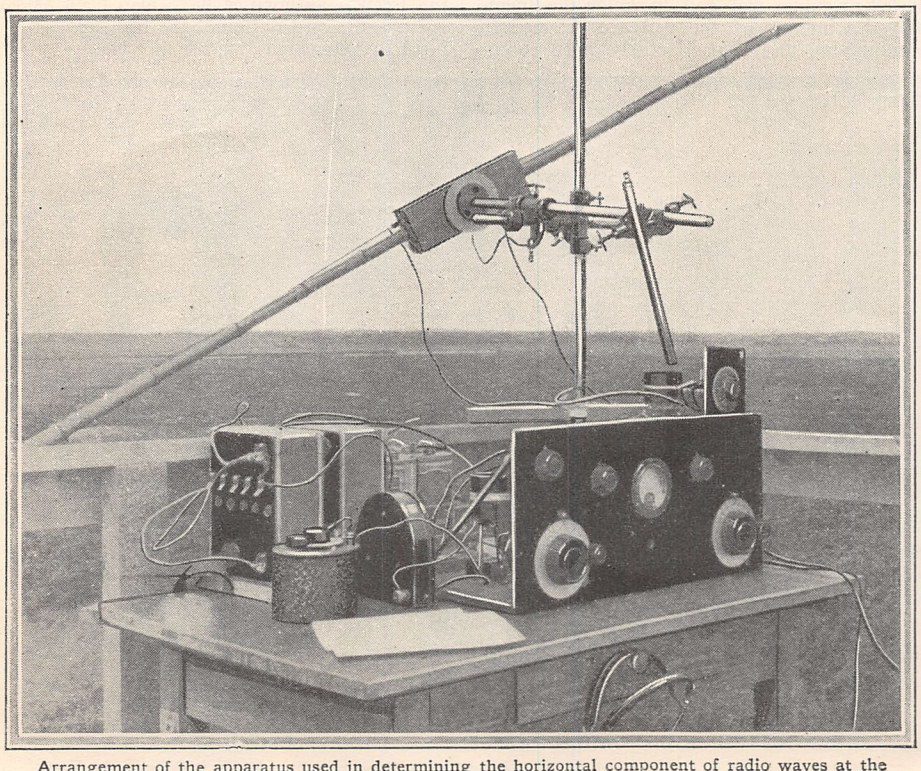


FIG. 1

The circuit used for obtaining the curves in Fig. 2, shown on the opposite page.



Arrangement of the apparatus used in determining the horizontal component of radio waves at the author's analyzer station.

WAVES IN THE UPPER ATMOSPHERE

Although Kennelly in 1902, (and a little later Heaviside) pointed out the possibility that ionization in the upper atmosphere might bend back to earth some of the upwardly-directed radiation from a transmitter, it is only in the last few years that radio engineers in general have appreciated the probability that the useful part of the radiation in long-distance working does not cling to the surface of the earth, but instead follows some sort of trajectory, much like that of a projectile in high-angle fire. If this is true, and evidence to this end is now accumulating rapidly, then the early objections to horizontally-polarized radiation quite literally fall to and remain on the ground. It is true, as Marconi said in 1899, that horizontally-polarized waves, proceeding along the surface of the earth, would be rapidly attenuated. It is also true that Artom's circularly-polarized waves would soon be damped out and resolved into plane-polarized radiation, if they were sent out horizontally and continued to cling to the surface of the ground. But with upwardly-directed radiation (and some of the radiation from any transmitter is so directed) the ground ceases to have any effect, save in the immediate vicinity of the transmitter and receiver.

Early in 1925 the writer's attention was directed to certain serious gaps in our knowl-

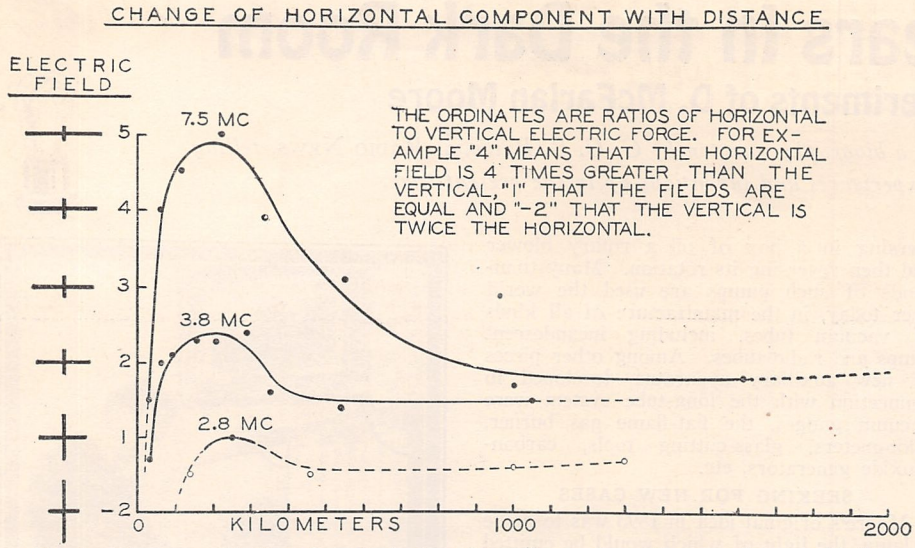

CHANGE OF HORIZONTAL COMPONENT WITH DISTANCE
ELECTRIC FIELD
7.5 MC
3.8 MC
2.8 MC
THE ORDINATES ARE RATIOS OF HORIZONTAL TO VERTICAL ELECTRIC FORCE. FOR EXAMPLE "4" MEANS THAT THE HORIZONTAL FIELD IS 4 TIMES GREATER THAN THE VERTICAL, "1" THAT THE FIELDS ARE EQUAL AND "-2" THAT THE VERTICAL IS TWICE THE HORIZONTAL.
5
4
3
2
1
-2
0
KILOMETERS
1000
2000

Fig. 2. These curves indicate how the horizontal component of a radio wave changes with the distance traveled at different frequencies.

edge of radio transmission. As said above, prior investigators had measured the plane of polarization of waves at considerable distances from the transmitter, and had always found them substantially vertically plane-polarized; but their measurements had been carried out only with waves which were vertically polarized at the source, and only over the lower transmission frequencies. This left unanswered the question of what would happen if the waves left the transmitter horizontally-polarized, and the further question whether vertical waves at very high frequencies would remain vertical at all distances.

In March, 1925, Nichols and Schelleng suggested that a form of the Faraday effect might exist in our atmosphere, capable of twisting the plane of polarization of radio waves through large angles, particularly at high frequencies. At about the same time, an elevated horizontal doublet at Schenectady began experimental transmission of horizontally-polarized waves at a frequency of 790 kilocycles (380 meters); and at the writer's laboratory at Newton Centre, Mass., this transmission was received on a vertical antenna with approximately the same intensity as if it had been radiated from a conventional vertical aerial. Inasmuch as a vertical antenna acts as an analyzer for polarized waves, giving maximum response to vertical waves, and none at all to horizontal, this test indicated that there had been a twist of 90° in the wave traveling from Schenectady to Newton, which had transformed a considerable part of it from horizontal to vertical.

TESTING THE WAVE'S POLARIZATION

In order to answer these questions satisfactorily, the following measurements were obviously necessary: first, a determination of the polarization at different distances from high-frequency transmitters, radiating vertically plane-polarized waves. Second, a comparison measurement, at both high and at low frequencies, from a distant transmitter which should radiate alternately vertical and horizontal waves. For these measurements a properly located analyzer station was required, capable of determining the direction and magnitude of the electric forces in waves from distant stations. The problem of a suitable location was easily solved by selecting a site on the flats at Seabrook Beach, N. H., which was singularly free from radio obstructions, such as hills, buildings and overhead wires which might further distort the waves to be measured. Here was erected a wooden tower, and thereon a linear Hertzian resonator on a universal joint, placing the receiving apparatus at the center of capacity of the resonator.

It must be borne in mind that, whenever such measurements are made at or near the surface of the earth, and a portion or all of the wave under observation is coming slantingly down upon the receiving point, a large part of the wave is reflected mirror-wise by the ground, particularly at the lower frequencies. As a result, and save for slight differential effects, the measurement is in general not that of the incident wave alone, but that of the resultant, of the incident and reflected ray. This imposes some rather serious limitations upon the things which we can measure. For example, it is difficult to determine whether the wave reaches the receiving point along a horizontal or an inclined path; and, equally, it is difficult to determine the exact angle of polarization in the incident ray.

By way of illustration, if an incident ray came down at an angle of 45°, plane-polarized, with the electric vector at 30° from the vertical; and if the reflection by the ground were substantially complete, it would be difficult to determine either of these angles. The resultant wave-front of the incident and reflected rays would be vertical, just as if the wave had arrived from the horizon; and the resonator would show a maximum electric force along a horizontal line at right angles to the bearing of the transmitter, having an amplitude half that of the vertical component. In other words, the wave would appear as if horizontally propagated and elliptically polarized, with the major and minor axes respectively vertical and horizontal. A true determination of both the angle of the incident ray and the exact direction of the electric forces might be made at extremely high frequencies over high-resistance ground; or, far better, by taking the apparatus a kilometer or two above the ground level in an airship or a captive observation balloon.

HOOK-UP OF THE APPARATUS

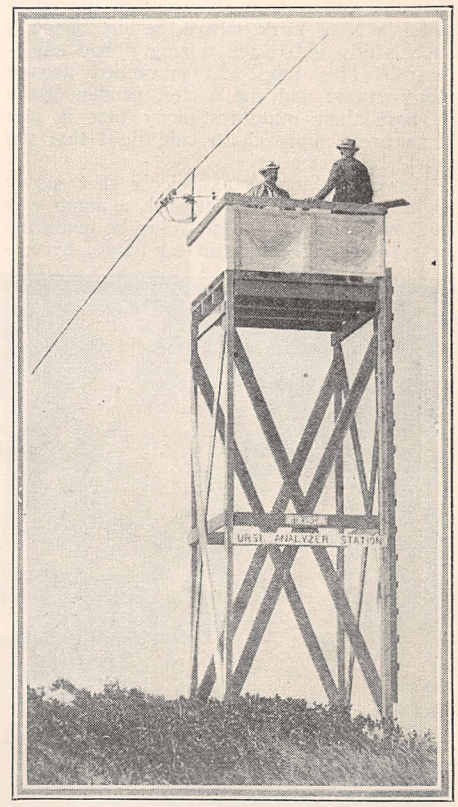
It was obviously impossible to carry the tower high enough to avoid the reflection effect of the ground. The resonator wire, 8 meters long, had its center 7 meters above the earth, which proved sufficient to prevent any material change in capacity of the system as the wire was rotated (which would have produced a change in signal intensity due to detuning). After some experiment, the circuit shown in Fig. 1 was evolved. The resonator wire is broken at its center, and a small tuning condenser inserted. In shunt with this condenser is an inductance coil, with its exact center grounded to the metalwork of the universal joint supporting the resonator, and also to the filament battery of the receiver. This partial ground determined a potential node at the center of the resonator system, which not only prevented disturbing effects from unsymmetrical capacities from the resonator wings to surrounding objects (such, for example, as the observer himself) but also gave the system marked directional properties in a horizontal plane.

A linear resonator gives maximum response when it is parallel to the electric field in the wave-front. When the resonator is at right angles to the electric field, but still parallel to the wave-front, the response is zero. But when the resonator is at right angles to the electric vector of the wave, but not parallel with the wave-front, a slight response may be obtained; because one wing of the resonator is excited slightly in advance of the other, and the currents flowing toward the center of the system no longer neutralize, as they are now not exactly 180° apart in phase. The partial grounding of the center of the resonator accentuates this effect, so that sharp nulls could be obtained by rotation either on a vertical or a horizontal axis.

Coupled to the resonator was the input circuit of a super-heterodyne receiver, using two stages of intermediate frequency amplification at 40 kilocycles (7,500 meters) and a single audio frequency stage after the second detector. In addition to the normal super-heterodyne oscillator, operating at input frequency plus or minus 40 kilocycles, a second oscillator was used, coupled into the second detector, and operating at a fixed frequency of 41 kilocycles. This produced an audio frequency note of 1,000 cycles, by beating with the intermediate frequency current, and greatly increased the intensity of the signal. For radiophone reception this second oscillator could not be employed, but the greater part of the measurements were made on C. W. code signals, where the second oscillator proved very useful.

The measured voltage amplification of the two intermediate frequency stages was 1200; but the loss in frequency conversion in the first detector brought the overall amplification from first detector grid to second detector grid down to 160, when the 41-kilocycle oscillator was not used. With this second oscillator in operation, a voltage

(*Continued on page* 1601)



The analyzer station at Seabrook Beach, N. H., where the work described herewith was performed.

Thirty Years In the Dark Room

The Experiments of D. McFarlan Moore

This is the final installment of a biography written by G. C. B. Rowe, of RADIO NEWS, *telling of Moore's experiences and inventions up to the present time.*

NO one knows what great and ofttimes undreamed-of uses the future may have in store for a new idea or invention. Even giving publicity to a new combination of old ideas has often started valuable developments; hence the great assistance being given to the advancement of science by technical publications.

Pure science is a misnomer. All scientific facts are ultimately applied, but often in fields far removed from those connected with their discovery. For example, the discovery of helium in the sun had seemingly no possible relation to wireless vision; neither did the scores of varieties, of what might have been called freak vacuum tubes, made by D. McFarlan Moore, mainly for lighting purposes. Yet each of his systems, consisting of light-giving glass tubes, often several hundred feet in length, demanded the development of much new auxiliary apparatus for both their manufacture and installation.

"EXHAUSTING WORK"

The first long tube of this character (that is, one built *in situ*) was attached to the marquee of Marceau's Studio and extended over the pavement on Fifth Avenue, New York. Probably a more elaborate piece of glass-blowing had never been attempted, as the 1¼-inch tube was 57 feet long; its involved curvature may be seen in the illustration on the next page. After the tube was judged to be free from cracks and pinholes, the next job was to remove the air from it by means of a high-vacuum pump. Therefore a large duplex Geissler mercury-pump, which weighed about 50 pounds and was exceedingly delicate and cumbersome, was equipped with handles. Moore and an assistant carried this pump from Newark to the curbstone in New York, where the big tube was successfully exhausted during a bad snowstorm. This tube was marvelled at for many years; and the icicles, pendant from it, bore their mute testimony that it was the nearest approach to cold light that the world had yet seen.

However, Moore's experience that snowy night proved to him that such a pump was not practical; and the next day he made the first rotary high-vacuum oil pump, by immersing in a box of oil a rotary blower and then reversing its rotation. Many thousands of such pumps are used the world over today, in the manufacture of all kinds of vacuum tubes, including incandescent lamps and radio tubes. Among other pieces of new auxiliary apparatus developed in connection with the long-tube system were vacuum gauges, the flat-flame gas burner, photometers, glass-cutting tools, carbon-dioxide generators, etc.

SEEKING FOR NEW GASES

Moore's original idea in 1893 was to make a lamp, the light of which would be emitted by a gas electrically agitated. However he was soon forced to realize how few gases there are that can be used as a solution of this great problem. A companion puzzle was the selection of the electrode material. It required great patience and persistence before Moore felt that he could say that there was no known gas, that could be used with any known electrodes, and become luminous from the simple application of commonly-distributed low voltage. It was then that the blank spaces, in the "periodic table" of the chemical elements, became of great interest. Argon was discovered in 1894 and Moore had read of Sir William Ramsay's interest in the missing elements; so he wrote to Ramsay of his belief that the further development of vacuum-tube lighting would be dependent upon the discovery of new elemental gases.

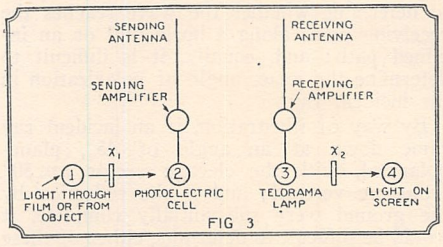
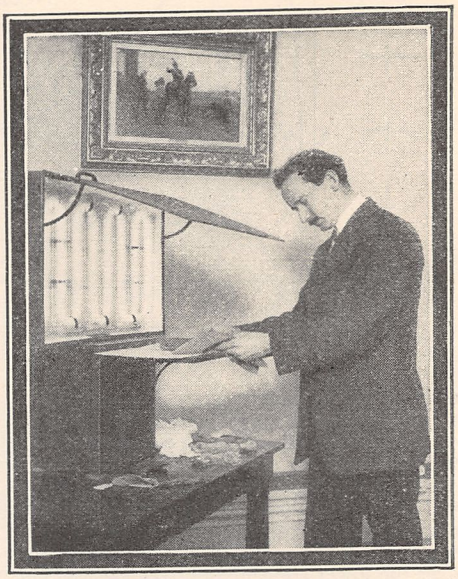


FIG 3

How moving objects or motion pictures are transmitted and received by radio is indicated in this diagram which is explained on page 1543.

Sir William with his contemporaries finally completed their determinations of argon, helium, neon, xenon, and krypton. When he came to America he called on Moore and in recognition of his prophecy and his work, presented to him a champagne bottle containing neon gas. It was the largest amount of the gas then in America and was worth at that time a thousand dollars. As the color of neon gas, when it is conducting electricity, is reddish, Moore when thanking Sir William said diplomatically, "I hope you discover another gas and that it will be white." Sir William answered by pushing aside apparatus on the dark room table, and after filling a sheet of paper with many ciphers, replied, "Well, if it is in the atmosphere, it can only constitute 1-25,000,000,000 of it."



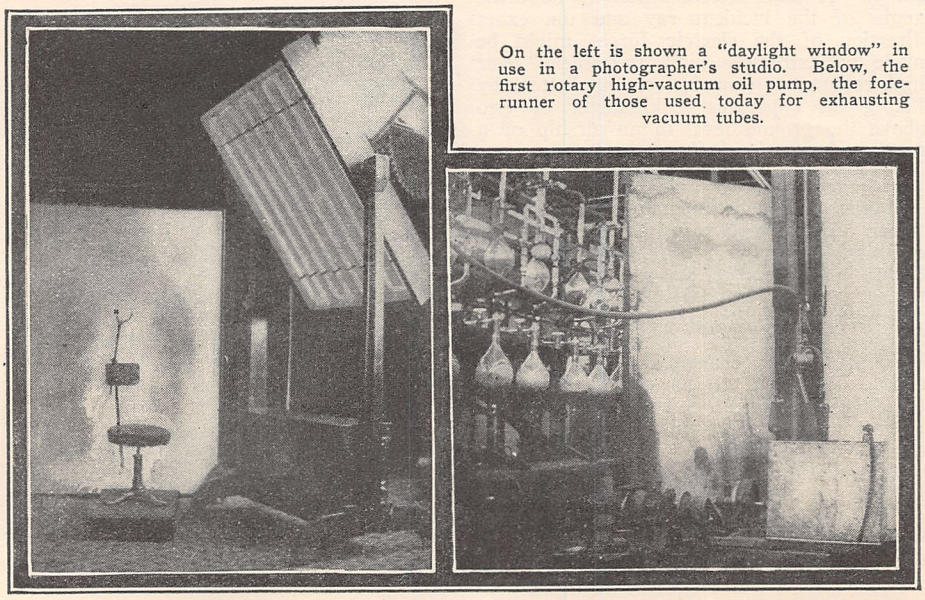
Mr. Moore matching colors, using his "artificial daylight window."

USING COMMERCIAL VOLTAGES

Moore charged some of his old lamps with what he called "Sir William's brand"; and there was thus produced the first self-starting, low-voltage, gaseous-conductor, corona lamp. These lamps are now made in many countries and in many types. Fig. 1 shows this original lamp, which was made in 1894, and required more than 220 volts to become luminous. This was because the conductivity of all gases then known was not high; and therefore it was necessary to use either a transformer of an intermittent-induction circuit to obtain higher potentials. This latter method Moore accomplished with his remarkably efficient vacuum-break.

Nevertheless it was highly desirable to eliminate all auxiliary apparatus, and produce a lamp for 110- and 220-volt circuits which would parallel the wonderful simplicity of the ordinary incandescent lamp. However his lamp was structurally sound; so that after it was re-exhausted and filled with about a 30-mm. pressure of the new neon gas, the close-fitting negative glow appeared over the entire surface of the two aluminum spiral electrodes, when an alternating circuit of low potential was applied. (See Fig. 1.)

Of course, the theory explaining the cause of this kind of luminosity is the same, no matter what particular gas or combination of gases is used; but it differs radically from that of all forms of incandescent lamps, the light of which is a simple by-product of a



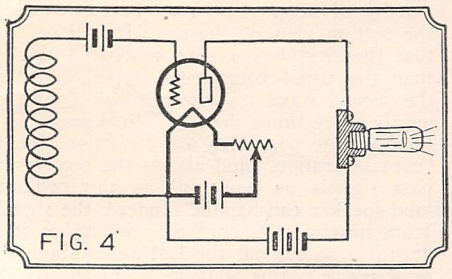
On the left is shown a "daylight window" in use in a photographer's studio. Below, the first rotary high-vacuum oil pump, the forerunner of those used today for exhausting vacuum tubes.

hot wire. In the negative-glow or corona lamp the circuit is not continuous and the electrodes are hardly warm—in fact, often at the temperature of the room. It is "luminescent" light. The electricity, in flowing between the electrodes, causes the intervening gas to be brought to luminescence by electronic bombardment.

THE NEON LAMP

Neon gas, which is a by-product of liquid air, and constitutes one part in every 66,000 of the atmosphere, is particularly suitable for such lamps, because of the location of the highly luminous lines in its spectrum, its inertness and its high conductivity. Its resistance to current flow is only about 1-165 that of air.

When neon is used as the gaseous conductor of long positive columns it is a highly-efficient light source; but when the lamp has no positive column and the light is all negative glow, it is not efficient. Moore made lamps of this general character that consumed as high as 100 watts; and described some of them in a paper presented through the A. I. E. E. in March 1920.* However, a modified line of these lamps was shown in a paper to the Illuminating Engineering Society in September, 1925, which seems even more interesting and capable of practical application in a great variety of fields. The reader's attention is called particularly to Fig. 2, which shows the "telorama," or television lamp, which Moore believes will prove the essential element when seeing attachments are on all radio receiving sets. They will be one of the important factors in the great world-changes, that are destined to come in the next decade, and will effect our lives to a greater extent than have the marvels of the past ten years.

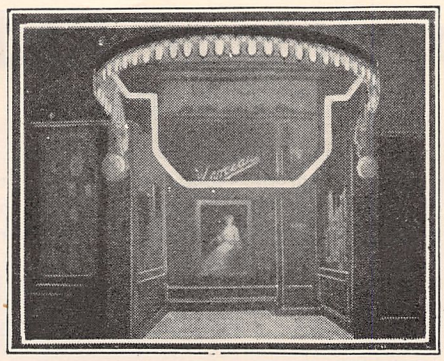


The diagram of connections, used in the reception of moving pictures by radio, with the telorama lamp.

SEEING BY RADIO

"Closer contact" of all humanity are the key words. We will then hear and see everything that is transpiring on the whole of the earth's surface. It will then be simply a matter of choice as to just what you will select to see and hear, exactly as you may do today with printed matter and radio broadcasting.

In March, 1924, Moore broadcast over WJY on the subject of the telorama, or seeing electrically. He claims that the best way to make the Treaty of Locarno permanent is to hurry up radio. In fact, it is the only hope. Unless the world knows the Balkan States better and they know the outer world better, war is sure again to break out.



The Moore tube that illuminated Marceau's establishment on Fifth Ave. was a close approach to "cold light."

There is abroad a general idea that, the more marvelous a new invention, the more difficult it will be to understand why it produces such marvelous results. It has been found that only a very small percentage of the principles disclosed by the technical magazines are actually grasped by the average reader. It is hoped that the following description of the telorama may be so clear that every one will have a satisfactory understanding of "how it works."

Fig. 3 shows the most essential factors, diagrammatically. All objects that are seen are continually reflecting light, as shown at 1. Some parts reflect more light than others; particularly so if the object is moving. When this reflected light, which does not have a constant intensity, shines on a photo-electric cell (shown at 2) the result is that through amplifiers radio impulses, which also vary in strength, leave the sending antenna. The receiving antenna passes them through amplifiers to the wonderful telorama lamp, as shown at 3. This gives out an ever-changing light in accordance with the received impulses, and it reaches the screen as shown at 4.

Two companion mechanical and optical devices are also necessary, the one shown at x1, and the other at x2. Many have been invented; but the discs of C. Francis Jenkins have less limitations than any other known methods. The function of these two devices is to properly place the flashes of light, brighter and dimmer, first on the photo-electric cell at 2, and second on the screen at 4, so that a picture there will be made up like the one at the sending station, 1. If the picture at the sending station is a moving scene, it is only necessary that the whole scene be sent every sixteenth of a second, in order that radio movies may appear on the receiving screen.

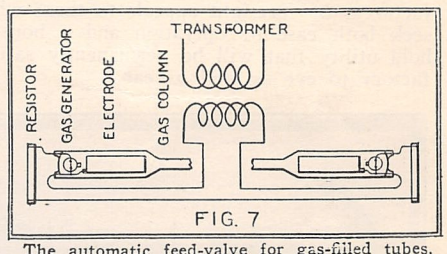
THE TELORAMA LAMP

However, the most important factor necessary for a telorama receiver is the lamp 3, which is so sensitive that it gives out more light when the radio impulse is strong, and less light when the impulse is weak. It corresponds directly with the most important factor of the telorama sender; viz, the photo-electric cell 2, which changes light pulsations into electrical pulsations. The lamp is the inverse equivalent of the cell, and it must be a gaseous-conductor lamp with cold electrodes. No form of heated filament light can be completely extinguished in one-sixteenth of a second; but with the telorama lamp this can be done with ease, and thus the appearance of continuous motion transmitted to the eye, the same as in ordinary motion pictures.

A variety of methods have been evolved to prove that this gaseous-conductor lamp loses its luminosity almost instantly after its supply circuit is broken. In fact, some measurements have indicated that only a millionth of a second is required. Fig. 4 shows the lamp located in the plate circuit of a simple hook-up. Of course, we will have seeing attachments on our ordinary house telephones, but doubtless the largest field by far is that of radio.

"DAYLIGHT LAMP DEVELOPMENTS"

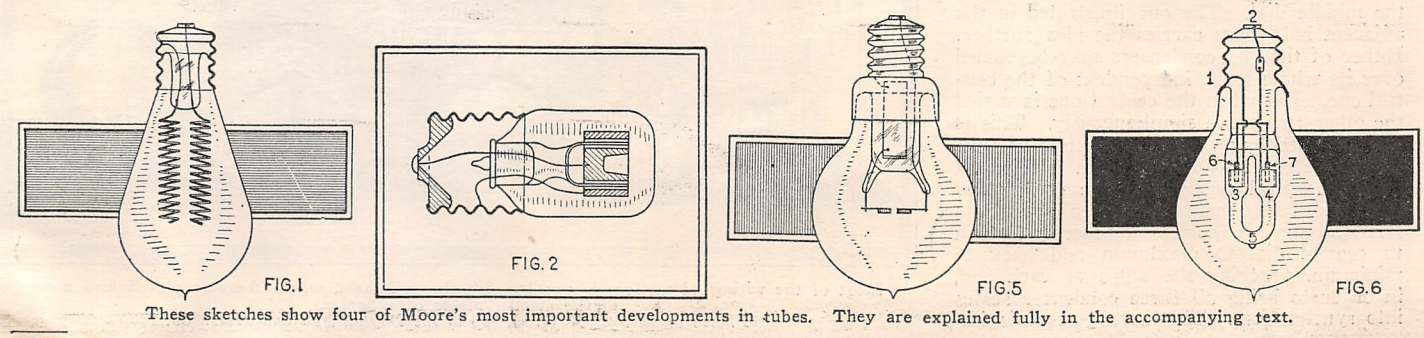
The reader has previously been told of the pioneer work Moore did in the realm of color, and his correct insistance that the light shed from his tubes filled with carbon dioxide produced daylight color-values. Some of these tubes were 100 feet or more in length, and others in the form of comparatively small, portable metal cases—called windows. One variety of these artificial daylight windows was four feet wide and six feet high. Moore had it supported on trunions like a huge cheval glass. The highest class of photographers used it, and said that the portraits obtained were unsurpassed. However, the automagnetic feed valve necessary with these large tube lamps did not lend itself particularly well to portability. Moore finally developed a portable and self-contained tube lamp as shown in Fig. 7. The development of this tube also involves much spectrophotometric work; as indicated in a paper presented to the I. E. S., in November, 1915, which discloses that he developed the formula for making the paint used in all of the precision photometers in the world today.



The automatic feed-valve for gas-filled tubes, developed by Moore, was a great step forward in their evolution.

Before the United States went into the World War, Moore as Vice-President of the Orange Chapter of the Sons of the American Revolution was active patriotically in many ways. During the war he found time as a "Four Minute" man to make good use of his early developed talent as a public speaker, by addressing collectively about a half million people. He also responded to the call to organize the East Orange Rifles and served until the armistice. He was also Executive Secretary for the State of New Jersey, during the great Red Cross Drive.

(*Continued on page* 1607)

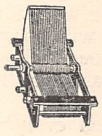


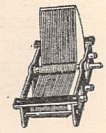
These sketches show four of Moore's most important developments in tubes. They are explained fully in the accompanying text.

* *See also* THE EXPERIMENTER, *January, 1926, and* RADIO NEWS, *September,* 1925.

New Developments in Radio Apparatus

By G. C. B. ROWE



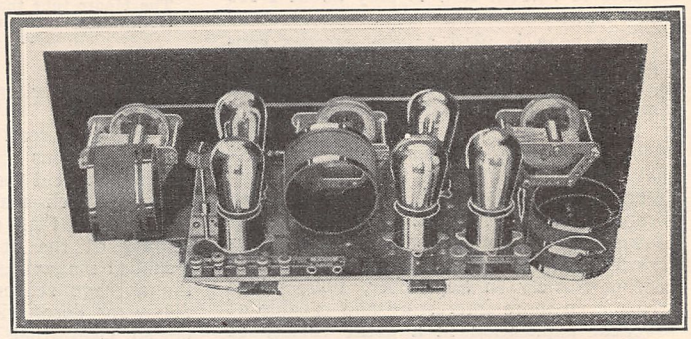


Radio design tends, day by day, toward simpler operation as well as graceful design. The set owner has a royal road to radio reception, compared with the experimental labor he once had to go through. And with the solution of engineering problems comes an era of new taste, in the production of the cabinet work that houses radio receivers, gracefully and simply.

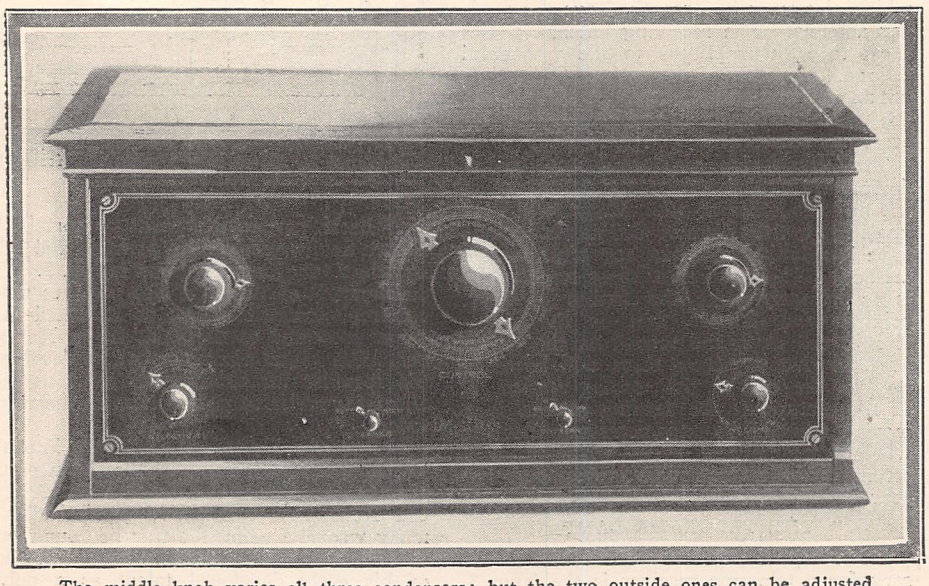
TO the devotee of excellence in radio, whether he be an engineer with an alphabet after his name, or a neophyte making the first plunge, there is something inherently satisfying in viewing a piece of work efficiently and harmoniously done. The former will take most pleasure in appreciating the difficulties that have been surmounted and the ingenuity that has been displayed; but both will realize the attractiveness in a product of radio science which can prove its merit; as well as enjoy the harmony in every line of the newer radio cabinets, that have outlived the period of the grotesque and the flamboyant in wood work.

This is a period of rapid development—not in the science of radio, but in the application of the principles of taste and comfort to produce a commercial product worthy of endorsement by a buying public which seeks, no longer novelty, but permanence. In this respect, whatever scientific developments the future may afford, radio has entered upon its final stage.

The newest apparatus offered by manufacturers of foresight appeals to those who seek both ease of operation and a household utility that will be permanently satisfactory to eye as well as ear.



This five-tube receiver can be tuned with one dial, though each condenser may be varied separately. The connecting cable is seen running over the pulleys in front of the variable condensers. The radio frequency transformers are immediately behind the latter.



The middle knob varies all three condensers; but the two outside ones can be adjusted independently.

A SET FEATURING MASTER, INSTEAD OF SINGLE CONTROL

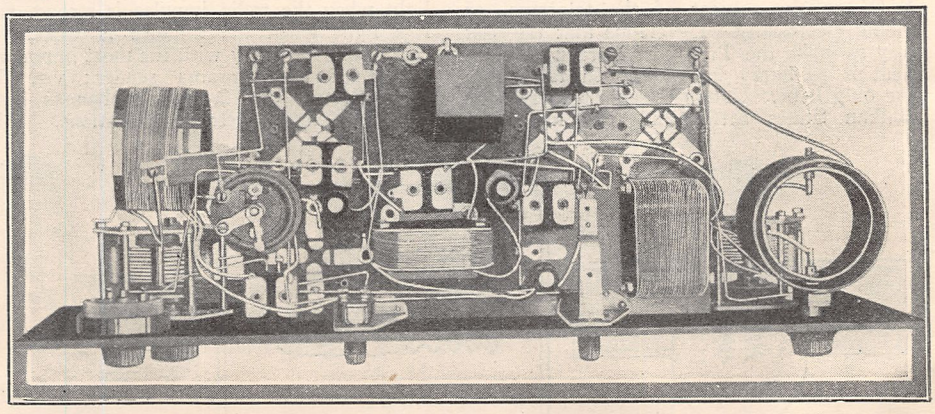
A receiver described in April RADIO NEWS provides limited adjustment of the two end condensers, and single control by means of the middle dial. The one illustrated in the adjacent half-tones carries the idea further. Either of the end condensers may be varied over its whole scale, independent of the central one. But when the central one is varied the other two move simultaneously. This is accomplished by an ingenious system of friction belts, the tension on which is supplied by small spiral springs. Aside from other advantages, this makes the three condensers self-aligning. It is necessary merely to turn th central dial to maximum and back to minimum, touching the stops at each end, in order to bring all three condenser scales into synchronism. This arrangement is important, because it allows a rough adjustment with maximum speed, and the fine adjustments to be made with great accuracy. Thus it is possible to have each stage very selective, and still retain single control of the main tuning operation. In practice the side knobs need be adjusted only when distant stations are being tuned in. For all ordinary signals the condensers remain in close enough synchronism to preclude the necessity of more than a single adjustment.

The knob in the lower left hand corner of the front panel is a selectivity control. Actually it varies the coupling between the antenna and the grid circuit of the first tube. This coupler may be seen in the lower right-hand corner of both the rear and the bottom views. Fixed coupling transformers are used in the output of the two radio frequency tubes. The detector is conventional and has special rheostat control. The design of the audio frequency transformers is especially worthy of note. This may be examined in the bottom view of the set. It will be seen that the first has a core somewhat thicker than the usual commercial types, and that the second stage transformer has a core of nearly three times the usual thickness. This removes the possibility of distortion due to "core saturation," and allows the receiver to pass signals as powerful as any ordinary loud speaker can handle. Indeed, the signals from nearby stations are so loud that it is desirable to cut out the last audio stage for most work. This is done by means of the speaker switch, which is the left-hand one of the two small knobs below the master tuning control. The other is the filament switch, and controls the "A" battery supply to all tubes at once.

The knob on the lower right of the front panel is the filament rheostat. Another is provided inside the set, but this is adjusted only once, and remains unchanged in its original position until a change of tubes is made.

The set is constructed with such care that the makers invite users to tune in a station by setting the main control at the wavelength desired and then turning on the tubes.

When the use of an antenna shorter or longer than usual throws the first dial out of synchronism with the other two (due to the effect of added inductance and capacitance in the primary) the coupling adjustment, or selectivity control, should be left near zero.



Most of the wiring of this set is run beneath the sub-panel, where there is placed also most of the smaller pieces of apparatus.

Photos on this page by courtesy of the Dayton Fan and Motor Co.

In this position conditions in the antenna circuit will have a minimum effect upon the secondary winding in the grid circuit of the first tube. In other respects, however, the tuning is similar to that of any standard tuned radio frequency receiver.

ATTRACTIVE SIMPLICITY IN TUNED R.F. DESIGN

A receiver which attracts attention by virtue of its mechanical construction and simplicity of detail is shown herewith. In this receiver the radio frequency and audio frequency units are constructed on separate sub-panels; and in order to save space and simplify the controls there is one gang and one ordinary condenser for tuning the radio frequency amplifier stages.

The arrangement of apparatus is also noteworthy, as here again is simplicity and at the same time neatness in design. The two radio frequency transformers, which are tuned by the gang condenser, are so placed that the leads to them are the shortest possible. The radio frequency transformers are also wound in an unusual manner, as they have the primary winding wound on the same tube as the secondary and in the middle of the latter instead of being wound over and under it.

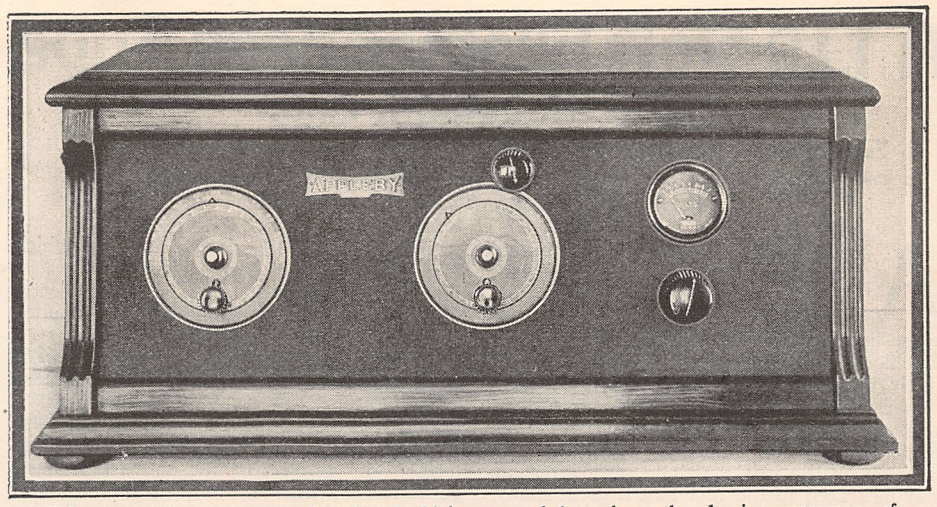
The circuit employed in this receiver is two stages of tuned radio frequency amplification, detector and two stages of audio frequency amplification. Oscillations inherent in this type of circuit, caused by magnetic and capacity feed-back, are retarded by feeding the plate potential through the primary coils to the first and second stage transformers, from the grid end of the secondary, and by the introduction of just enough losses through eddy currents to stabilize the circuit. These losses are produced by the proper placing of the second radio frequency transformer in relation to the metal shielding. It is not possible to arrive at this position mathematically but only through experimentation.

This receiver has a wave-length range that is above and below any of the wave-lengths used by broadcast stations in this country at the present time. It can be tuned from 185 meters to 570 meters; and the reception is said to be clear and efficient over the whole range.

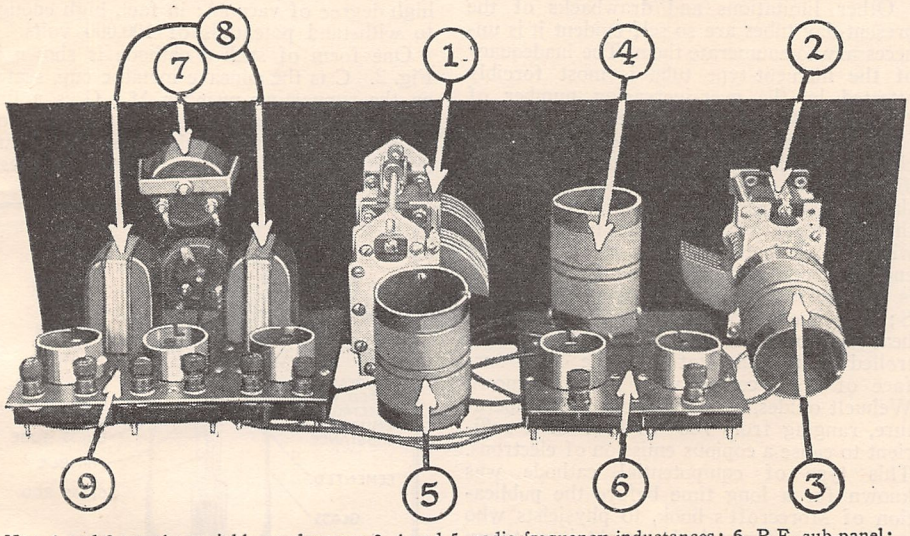
KEEPING POSTED ON YOUR BATTERIES

One of the unescapable chores of owning a radio set—few though they are nowadays—is the attention that must be paid to the batteries supplying the current to the tubes in the receiver. How often have we heard the lament, "Oh, why didn't I charge my storage battery last night?" The answer, in nine cases out of ten, is that the battery is allowed to go on its own sweet way without a thought until it just naturally keels over from exhaustion.

To many fans the thought of grabbing a hydrometer and finding out if the battery needs charging seems repulsive, for some strange unknown reason. Why this is so we will not hazard even a wild guess, but alas, such is the case. However for those gentlemen, who have the anti-hydrometer complex, there has lately been introduced a remedy.



This view of the receiver, the interior of which appears below, shows the pleasing appearance of the panel, its two tuning controls and the voltmeter.
Courtesy of Appleby Manufacturing Co.



Nos. 1 and 2 are the variable condensers; 3, 4 and 5, radio frequency inductances; 6, R.F. sub-panel; 7 voltmeter; 8, A.F. Transformer; 9, detector and A.F. sub-panel.
Courtesy of Appleby Manufacturing Co.

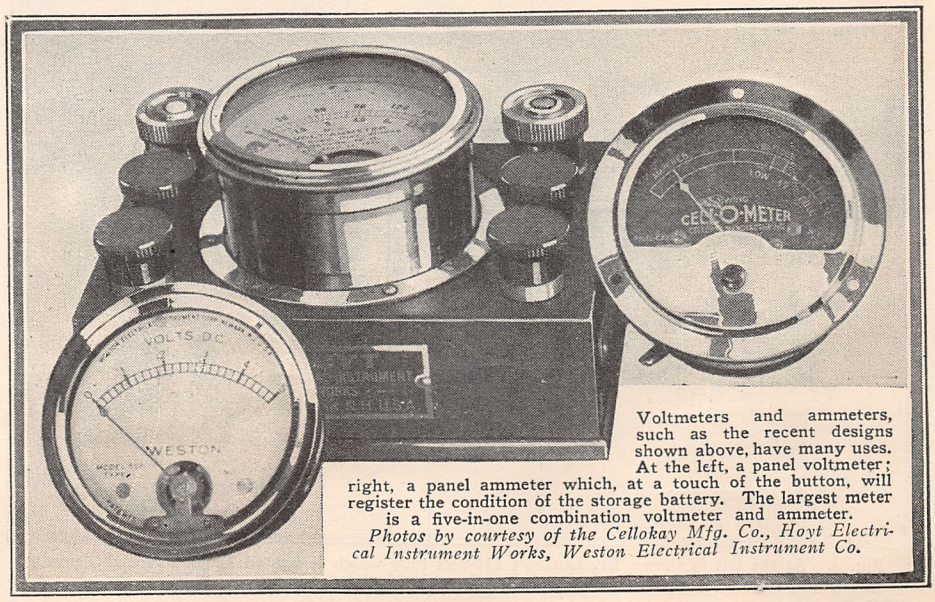
This remedy is shown in the accompanying illustration. The panel meter with the double scale should prove to be a boon to the gentlemen with the complex that we mentioned above. On the left side of the scale is indicated what the battery is doing; *i. e.* whether it is discharging or being charged. This is a great advantage, for many times the battery charger is in the cellar along with the storage battery and the set is upstairs. Now it is entirely possible for a system of switches to be devised so that, by merely throwing a switch, the battery is put on charge and the rate may be observed by means of this meter.

But we can hear our friend with the complex mutter, "How does that save my poking a hydrometer into the battery?" He

(*Continued on page* 1611)

Again this month RADIO NEWS is obliged to reject the publication of 1,780 lines of advertising, because of false or misleading statements, grossly exaggerated claims, or because the article in our opinion was without merit. This represents a total of more than four pages of advertising, at a cash value of $4,450.00.

The RADIO NEWS LABORATORIES' Seal of Approval is your guarantee that the article bearing it is electrically and mechanically worthy. Seals are not issued on the general reputation of a manufacturer, but only after actual inspection and test of the apparatus in our Laboratories.



Voltmeters and ammeters, such as the recent designs shown above, have many uses. At the left, a panel voltmeter; right, a panel ammeter which, at a touch of the button, will register the condition of the storage battery. The largest meter is a five-in-one combination voltmeter and ammeter.
Photos by courtesy of the Cellokay Mfg. Co., Hoyt Electrical Instrument Works, Weston Electrical Instrument Co.

A 110-Volt Filamentless Tube

By A. N. LUCIAN, Ph.D.*

The author of this interesting article on a new type of vacuum tube, for receiving radio impulses, has for many years devoted his time to the study of all types of tubes and their construction.

A GREAT deal is now written and speculated about the practical possibilities of vacuum tubes operating directly or indirectly from the house-lighting circuit. The first reason for this flood of discussion, perhaps, is a perfectly natural desire to do away with such cumbersome and expensive adjuncts as storage and dry-cell batteries, chargers and eliminators, which accompany almost every set now on the market. The second reason may be traced to the fact that a great many keen experimenters have, for some time past, been working toward a solution of this problem; and news of their work, or of their dreams (mainly the latter), has leaked out to the outside world.

The first reason mentioned above is bound up with inherent limitations of the ordinary vacuum tube, universally used in radio work. Any tube in which the source of electron

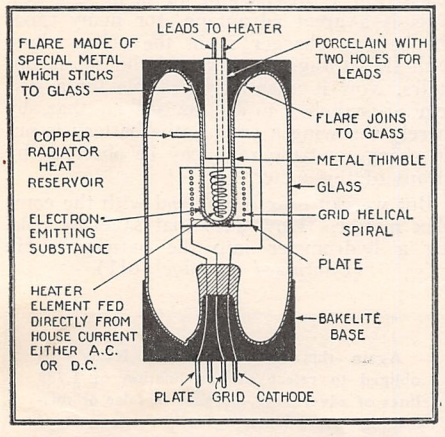


Fig. 4. In this tube Dr. Lucian heats the metal thimble, from the concave side, with 110-volt house current. It takes the place of a filament.

emission is a filament, enclosed in a vacuum chamber, is subject to serious disadvantages. Among these, the more important ones are the following:

DRAWBACKS OF FILAMENT TUBES

(1). The life of the tube is dependent entirely upon the life of the filament, which is generally rather short.

(2). The filament requires a perfectly steady source of direct current, supplied usually from a storage battery.

(3). The storage battery brings with it the additional trouble and cost of battery charging.

(4). If the filament should, by accident, be burned out at any time before the normal term of its active life, the entire tube must be replaced; thus forcing upon the radio public a burden of expense, continually increasing with the number of tubes used in the average set of today.

(5). The use of 6-volt A.C. stepped down from the house current is, in general, impossible without introducing the hum of the 60-cycle current. Use of either A.C. or D.C. house current introduces cumbersome and expensive apparatus.

Other limitations and drawbacks of the present-day tubes are so self-evident it is unnecessary to enumerate them. The inadequacy of the filament-type tube is most forcibly attested by the ever-increasing number of "A" and "B" battery eliminators.

Prof. Morecroft, in his book on "Principles of Radio Communication," (Page 379) discusses the use of a so-called "equi-potential" cathode, as shown in Fig. 1. C is a thimble, made of a suitable metal, within which is enclosed the heating coil H, one end of which is grounded on C, and which is fed by suitable current from the source S; the amount of current, and hence the heat developed in the coil H, being controlled by the rheostat R. The other surface of C is coated with the well-known Wehuelt oxides, so that a moderate temperature, ranging from 700° to 1000°C. is sufficient to cause a copious emission of electrons. This type of equipotential cathode was known for a long time before the publication of Morecroft's book, to physicists who employed similar cathodes to obtain a stream of electrons of uniform velocity throughout.

The writer used, prior to 1918, similar cup-shaped cathodes coated with Wehuelt oxides and heated by coils placed adjacent to the concave face of the cathode, and was

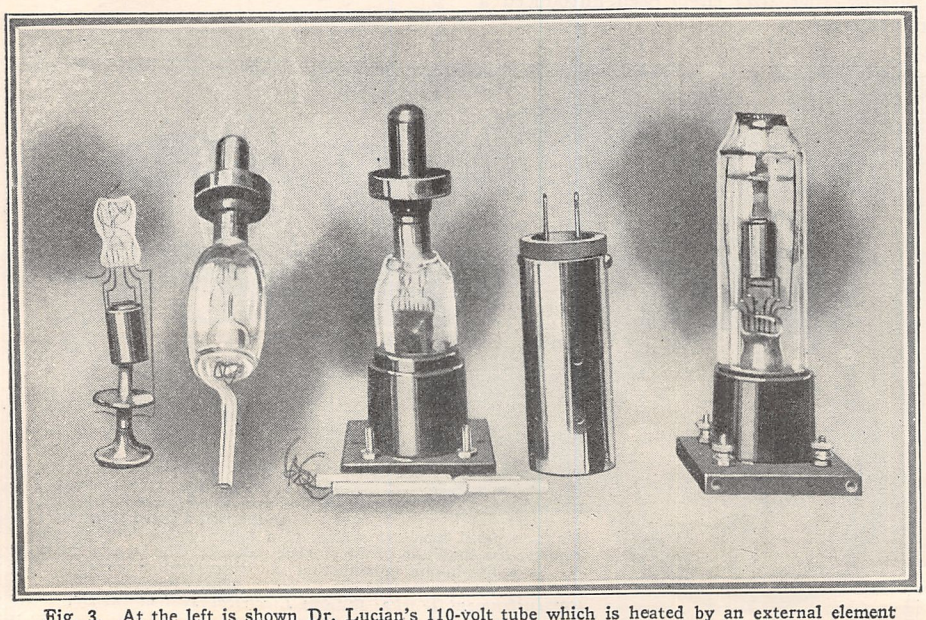
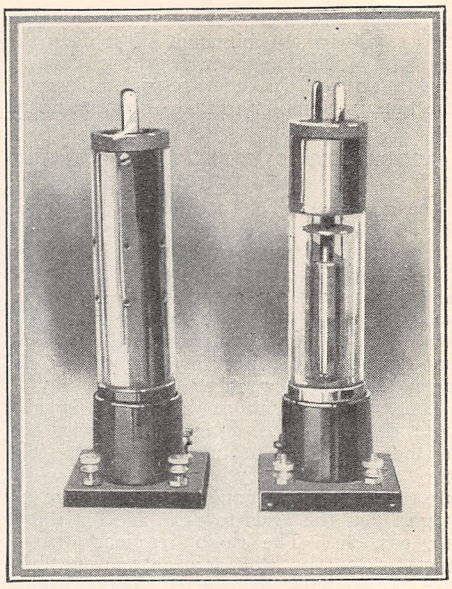


Fig. 3. At the left is shown Dr. Lucian's 110-volt tube which is heated by an external element (see Fig. 6) and on the right is shown the tube depicted diagrammatically in Fig. 4.



Above, two of Dr. Lucian's tubes. Right, the earlier model (Fig. 4). Left, the later type (Fig. 6.)

able to exhaust such X-ray tubes to a very high degree of vacuum; in fact, high enough to withstand potentials of 100,000 volts.

One form of such a cathode is shown in Fig. 2. C is the concave metallic cup, seated on the supporting member M. G is a fine mesh gauze attached to the surface of cathode C, and the Wehuelt oxides O are deposited on the gauze. In some of these,

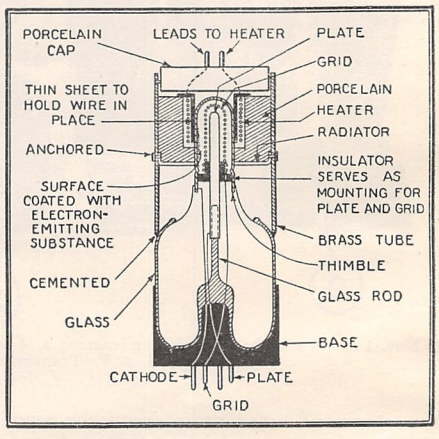


Fig. 6. In this type of tube the thimble is coated on the inside and heated by the external heating element. The grid and plate are inside the thimble.

the heating coil and a cup-shaped cathode were enclosed in the vacuum; in some others the heating coil was placed in the open air and adjacent to one face of the cathode, which formed a vacuum-tight partition or wall between the vacuum chamber and the outside air. The tubes to be described in this article make use of this early conception of the writer.

In the accompanying Fig. 4 is shown a somewhat diagrammatic vertical section of the first type of tube. It will be seen that the metal thimble, one face of which is coated with the electron-emitting oxides, has a flare of special material attached to it, and joined to the glass in the form of a ring seal. This material has the same thermal coefficient of expansion as glass; hence the seal is never under strain, whether the tube be cold or hot. The heating unit consists of a non-inductively wound coil of wire, with a hollow core, dipped in cement which gives it rigidity and also provides insulation. When the heater is supplied with electric current from any source whatsoever, A.C. or D.C. of any voltage desired or available, the unit is raised to a suitable high temperature.

* *Assistant Professor of Physics, University of Pennsylvania.*

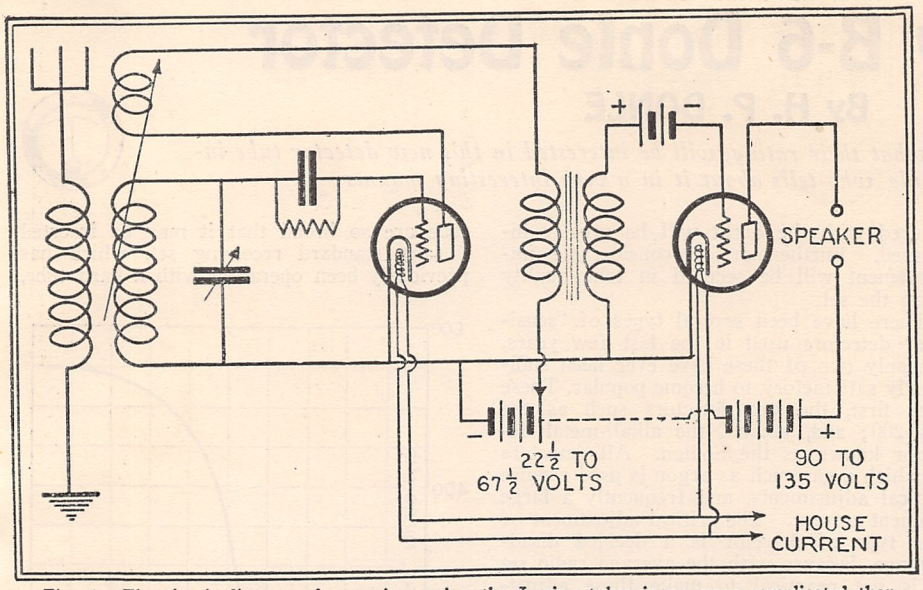


Fig. 5. The circuit diagram of a receiver using the Lucian tubes is no more complicated than that of an ordinary type of receiver.

This heat is immediately transferred, by the well-known process of conduction, radiation and the convection of air currents, to the metal thimble which in turn heats the layer of oxide on its other face.

As soon as the temperature of the oxide coating is raised to about 500° or 600° C., it

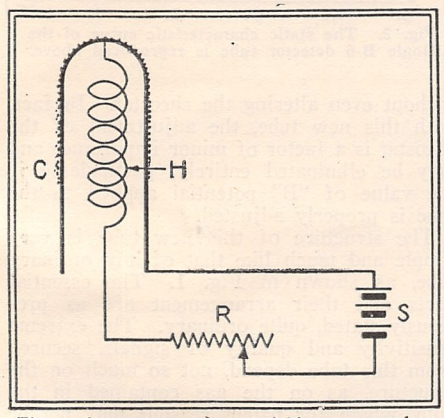


Fig. 1 shows an "equi-potential" vacuum tube. C is a metal thimble; H, a heating coil controlled by the rheostat, R.

begins to emit copious streams of electrons, and the tube is now ready to operate, since we have an element (supplanting the filament of the ordinary tube) which supplies us with our working agent; viz. the electron. It is of course, obvious that the transmission of heat from the heater to the thimble does not take place instantaneously. With the tubes which have been actually placed in working sets, signals become audible within about one minute after the current is turned on. By proper modification of the physical dimensions of the thimble, it will be possible to cut down this time lag to less than half a minute. It will also be observed that the heat transferred to the thimble will not be confined to the lower end of it, where the electron-emitting oxide coating is placed, but will travel along the entire length of the thimble as far as to the metal-to-glass joint. This means, not only danger to the joint, but also actual waste of electrical energy in producing heat, in places where heat is not needed nor desired.

INSULATING THE HOT CATHODE

To overcome this condition an investigation of possible thimble materials was made, and finally a metal was chosen which possesses an extremely low heat-conductivity (and naturally a correspondingly high electrical-resistivity), so that while the lower end of the thimble is kept at a bright red heat the upper portions showed no visible degree of temperature. Furthermore, to make sure that no appreciable quantity of heat could reach the metal-to-glass seal, one or more discs made of a metal of extremely high heat-conductivity, such as copper, are placed approximately half-way between the active portion of the thimble and the metal-to-glass joint. One function of this disc is to pick up any heat that may travel up the length of the thimble, and radiate it away, thus keeping the seal above it at a normally low temperature.

Another important factor in the choice of thimble material is the well-known physical phenomenon that a great many metals are actually porous to gases, especially when they are hot. We may get a rough mental picture of this phenomenon, if we picture to ourselves a wall made up of a large number of billiard balls piled together as tight as possible, but with no cement or filling in between. These billiard balls represent the molecular aggregates of a solid metal. Now if we have a blast of fine sand directed against such a wall, the obvious result is that a great many sand particles will get through the wall. The sand particles represent molecules of gas. It is thus easy to see why a solid metal, which forms a partition wall between a vacuum and the outside air, may easily let some gas molecules go through. It will be noted that most metals are actually porous to such light gases such as hydrogen. Examples of such metals are platinum, palladium, etc. But this is not true for air. It is possible to select metallic substances which are perfectly impervious to the passage of air through them. This has been satisfactorily demonstrated in these tubes, where thimbles built and sealed into exhausted vacuum tubes have been operating for months and years without any sensible depreciation of the vacuum.

USE OF HOUSE LIGHTING CIRCUIT

It will be observed that the rest of the tube shown in Fig. 4 is very similar to a standard tube, with cylindrical elements. However, it should be appreciated that the heating circuit, which is usually supplied from the house mains, is placed on the upper end of the tube, entirely separated physically, as well as electrically, from the operating end of the tube. The operating end of the tube is enclosed within a regular standard base, which fits the standard socket of the ordinary set. The plate and grid leads are in their proper places; but since no filament exists in this tube, the cathode lead is brought down to the negative filament lead and the two filament leads are preferably short-circuited. This, of course, is done within the base of the tube, so that no change is required in using this tube in an ordinary set, except the provision of suitable cables and standard connectors from the house wires to the heating element. The connectors to the heating element are so designed that they are easily detachable from the tube, so that when a heater burns out and the tube temporarily stops functioning, an inexperienced operator can take the old heater out and replace it with a new one in a few minutes. It might be worthwhile to mention that the life of a heater is about as long as that of the filament in the ordinary 201-A type of tube.

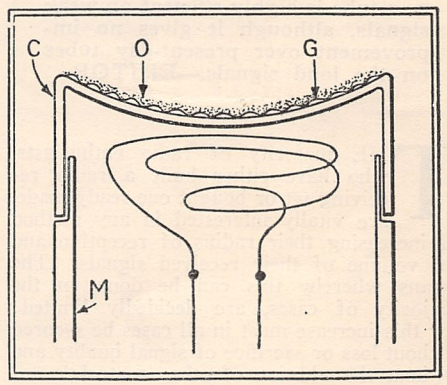


Fig. 2 represents a cup-shaped cathode used by the author in X-ray tubes. M supports C, the cup, on which is wire gauze, G, coated with oxides, O.

GRID AND PLATE INSIDE

After discussing the first type of tube more or less fully, it is not necessary to dwell on the details of the second type, shown in Fig. 6. Here the order of the elements is completely reversed, but the principle of a thimble-cathode, heated by an outside agency or source of heat is still retained. It will be noticed at once that the cathode thimble is made a great deal larger in

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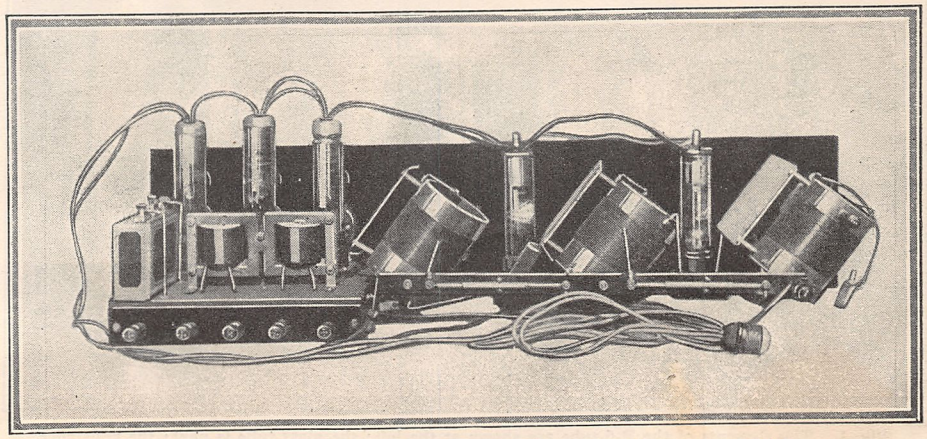


A neutrodyne receiver using five of the Lucian filamentless vacuum tubes.

The New B-6 Donle Detector

By H. P. DONLE

Radio enthusiasts, no matter what their rating, will be interested in this new detector tube invented by Mr. Donle, who tells about it in a very interesting manner.

HERE is a brand new thing in radio—not merely another tube. Mr. Donle, the inventor of the Sodion tube, is perhaps one of the greatest living vacuum tube experts in the world today, having to his credit over 100 patents on radio tubes alone. He has done a great deal of research work along these lines.

The new Donle Detector does a number of astonishing things. For instance, we have a set in the laboratories that, when tuned in to a Chicago station, can not be heard even with headphones. By replacing the best detector tube we could find on the market with a Donle detector tube, the signals were brought in on the loud speaker—an astonishing performance.

Those interested in DX work, and those who wish to bring in the distant stations, will find the new detector tube of great interest. The new tube is highly efficient on weak signals, although it gives no improvement over present-day tubes on the loud signals.—EDITOR.

THE majority of radio enthusiasts, who have either built a radio receiving set or bought one ready-made, are vitally interested in any method of increasing their radius of reception and the volume of their received signals. The means whereby this can be done, in the majority of cases, are decidedly limited; for this increase must in all cases be secured without loss or sacrifice of signal quality and without the addition of other controls.

To secure an increase in volume-sensitivity of a receiving system usually implies considerable additions and alterations to the circuit, in both radio and audio stages.

There is one way, however, in which these very desirable improvements may be secured, by the simple substitution of a "sensitive detector" for the ordinary "hard" tube; and thus, without any changes in the circuit, the radius of reception and volume of signals secured with the outfit will be greatly increased. Furthermore, a considerable improvement will be secured in tone quality from the set.

There have been several types of "sensitive" detectors used in the last few years, but only two of these have ever been sufficiently satisfactory to become popular. These are: first, the gas detectors such as the UV-200; and, second, the alkali-metal detector known as the Sodion. All detectors in which a gas such as argon is used require critical adjustments, and frequently a large filament current. The critical adjustment of this type of detector is a decided disadvantage, because with the average radio set it is not practical to make these adjustments and, furthermore, these gas detectors do not give the quality of signals which can be secured by a properly-designed detector.

The Sodion detector gave far more satisfactory results than any detector used previously, on account of its simple and broad adjustment and its quality of signal. But for various reasons this detector has been withdrawn from the market.

NEEDS NO CRITICAL ADJUSTMENT

A new detector has been developed by the writer which gives very satisfactory results under all conditions: it is more sensitive than any detector previously used, it does not require critical adjustments, and it gives that round, full quality of tone so desirable in a receiving set. The adjustments of this tube are so broad that it may be inserted in any standard receiving set, which has previously been operating with a hard tube, without even altering the rheostat. In fact, with this new tube, the adjustment of the rheostat is a factor of minor importance and may be eliminated entirely, particularly if the value of "B" potential applied to the tube is properly adjusted.

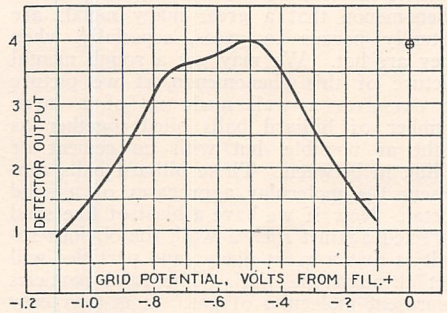


Fig. 3. Here is plotted the intensity of the signal at various values of grid voltage.

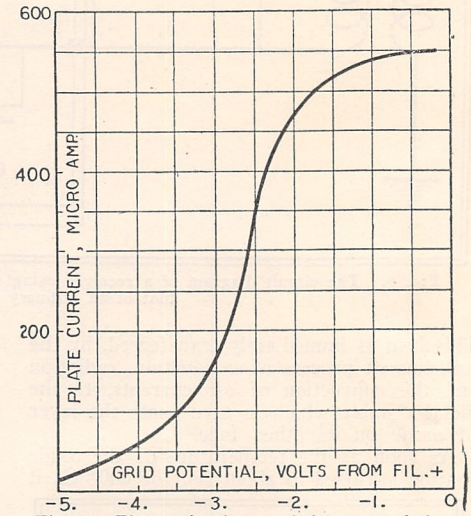


Fig. 2. The static characteristic curve of the Donle B-6 detector tube is reproduced above.

The structure of this new tube is very simple and much like that of any ordinary tube, as shown in Fig. 1. The essential parts and their arrangement are as previously stated, quite ordinary. The extreme sensitivity and quality of signals, secured from this tube depend, not so much on the structure, as on the gas contained in the bulb, which for patent reasons may not be completely described at the present time.

AUTOMATIC CURRENT CONTROL

In practice the resistance "R" is wrapped around the neck of the tube and is connected in series with the filament. This resistance plays an important part in the tube operation and has a distinct bearing on the blunt filament-current characteristic. The potential across the terminals of the filament in this tube is only 1.1 volts, but the potential across the outer terminals of the tube base is 5 volts. The difference between these two values is taken up in this resistance "R". The resistance consists of a short length of wire having a high temperature-coefficient of resistivity, and tends to maintain the filament current constant with varying battery voltages; thus practically eliminating one of the most disagreeable features connected with the use of a sensitive detector, that of critical filament-current adjustment.

The static characteristic of this tube is in many ways similar to that of any other tube, particularly to one in which ionization exists. Its curves are shown in Fig. 2, and were taken under the usual conditions. The particular point of interest in connection with these curves is that contrary to the usual idea, detection does not take place at a sharp kink or bend in the static characteristic.

In Fig. 3 the intensity of the received signal is shown, taken at various values of grid potential with a constant value of applied signal, this latter value being measured

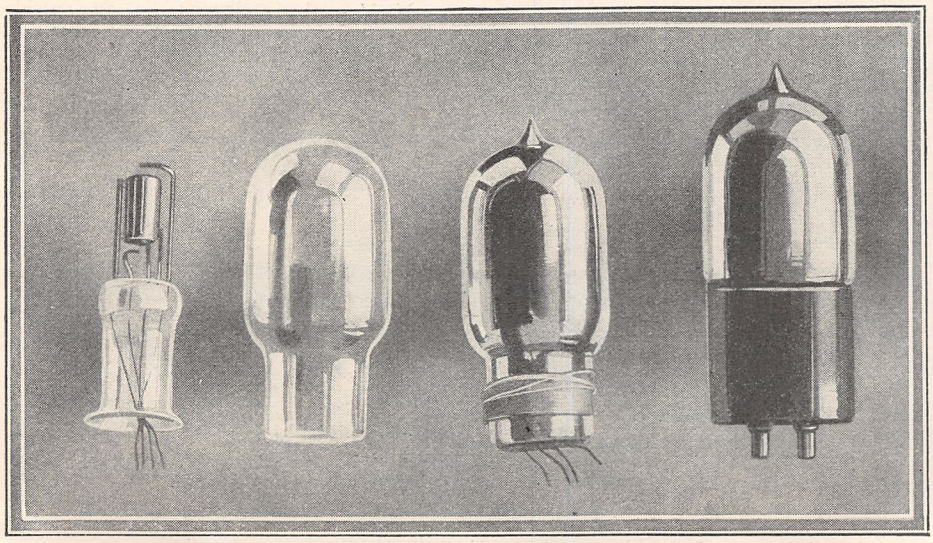
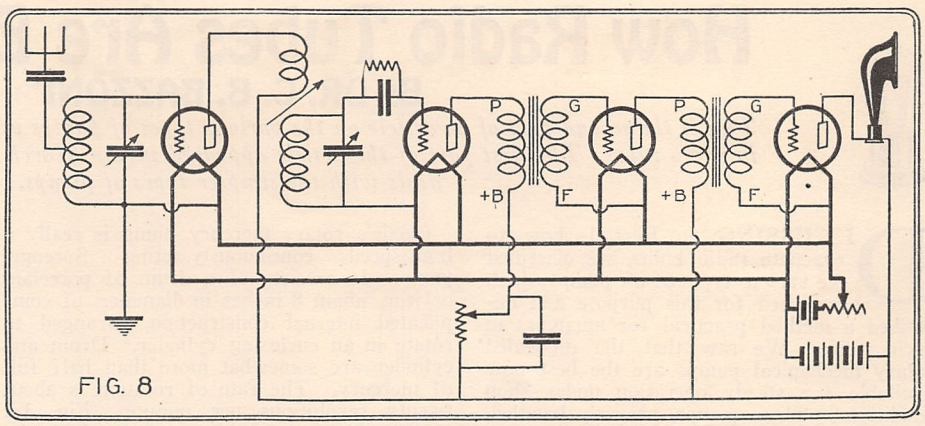


Fig. 1. The elements of the B-6 tube are shown at the left; the glass tube is next; the resistance that is in series with the filament is then shown wrapped around the glass and last is the finished tube. *Photo by courtesy of Donle-Bristol Corp.*

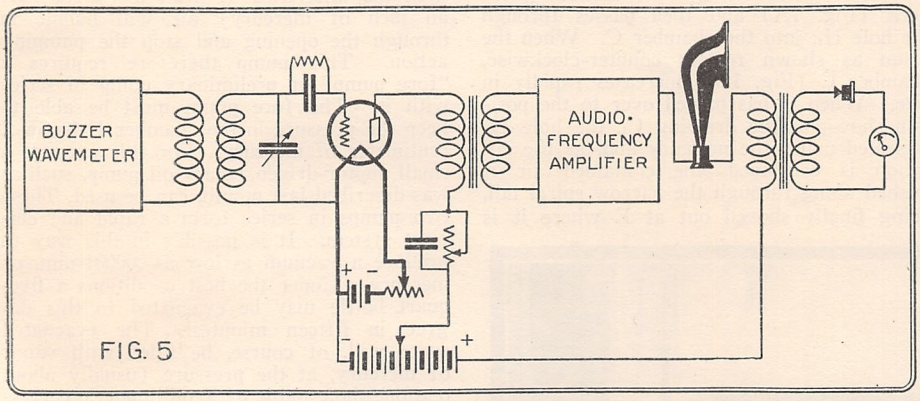
from the positive end of the filament. This curve indicates that the maximum response is secured at a point on the static characteristic at which there is no abrupt bend, and detection is due to another factor entirely.

ELIMINATING GRID-LEAK AND CONDENSER

Fig. 3, described above, which shows the intensity of signal at various grid voltages, is quite interesting because it indicates the very large signal which can be secured from this tube without the usual grid-leak and condenser. In order to show the relative magnitude of signal, detected with and without grid-leak and condenser, the signal with the grid-leak and condenser, taken for the same value of applied signal, is shown on this curve by the crossed circle. The comparison of these two methods shows a considerable variation for signals of different intensity; nevertheless, in general equally good results will always be secured with this tube without a grid-leak and condenser, particularly with the use of a potentiometer, which allows the grid potential to be fixed at the most appropriate value.



The circuit diagram of a receiver in which is incorporated the Donle B-6 detector tube. Notice the rheostate in the plate circuit to vary the voltage.



How the apparatus was connected to obtain the curves in Fig. 4. The variable distance is between the two inductances at the left.

SENSITIVITY ON WEAK SIGNALS

The matter of greatest interest in connection with this tube is its performance under actual operating conditions; that is, the output which it will give for applied signals of different intensity, and how it compares under these conditions with the usual detector. The results of such a test are shown in the curves of Fig. 4 which shows the response in telephone current, or current supplied to the audio amplifier system, given in arbitrary units for applied signals of varying intensity both with the new sensitive detector and with a typical "hard" tube. These curves indicate a very great gain on weak signals, decreasing as the signal increases, until both tubes give substantially the same results on the strongest signals. The point, however, where the performance of these tubes becomes nearly equal, is at a signal intensity which has practically saturated each tube; saturation occurring on the "sensitive" detector at a slightly lower signal than on the "hard" detector.

The means whereby these last curves were obtained may be of some interest. The circuit used is shown in Fig. 5, where the signal is secured from a buzzer-excited wavemeter placed at some distance from the detector testing circuit, and arranged so that its relation in regard to the inductance in the latter circuit may be readily altered. The grid circuit of the detector is connected to the usual type of capacity-inductance circuit.

The output of the detector passes into an ordinary two-stage audio amplifier. The output of this audio amplifier is connected to a loud speaker which is in series with the primary of a transformer. The secondary of this transformer is connected to a micro-ammeter through a crystal detector. This transformer is used for the purpose of separating the A.C. and D.C. components in the plate circuit of the audio amplifier, in order that the micro-ammeter may indicate only the alternating component, which is rectified by the crystal detector and indicated as a direct current on the meter.

RADIO NEWS has been favored in being able to obtain for experimental use several of the new B-6 Donle tubes described in this article; and tests are now being conducted by the RADIO NEWS LABORATORIES for the purposes of developing special circuits utilizing to its fullest value the remarkable sensitivity of these detectors. As soon as these have reached a suitable stage, they will be laid before our readers in a special article that will be of interest to every set builder and other DX seeker.

This circuit is exceedingly simple and allows direct comparisons to be made of various types of detector, the results of which may be read directly upon a meter, thus eliminating the uncertainty and errors accompanying the use of audibility measurements. Furthermore, slight differences in operation which would be difficult and almost impossible to detect by means of audibility measurements are most clearly indicated with this circuit. The horizontal scale of Fig. 4 shows the distance between

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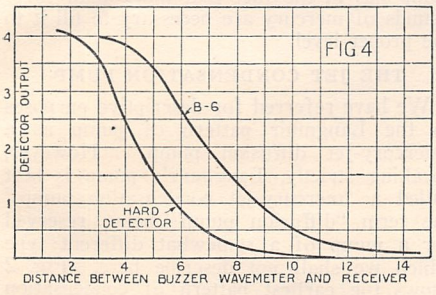
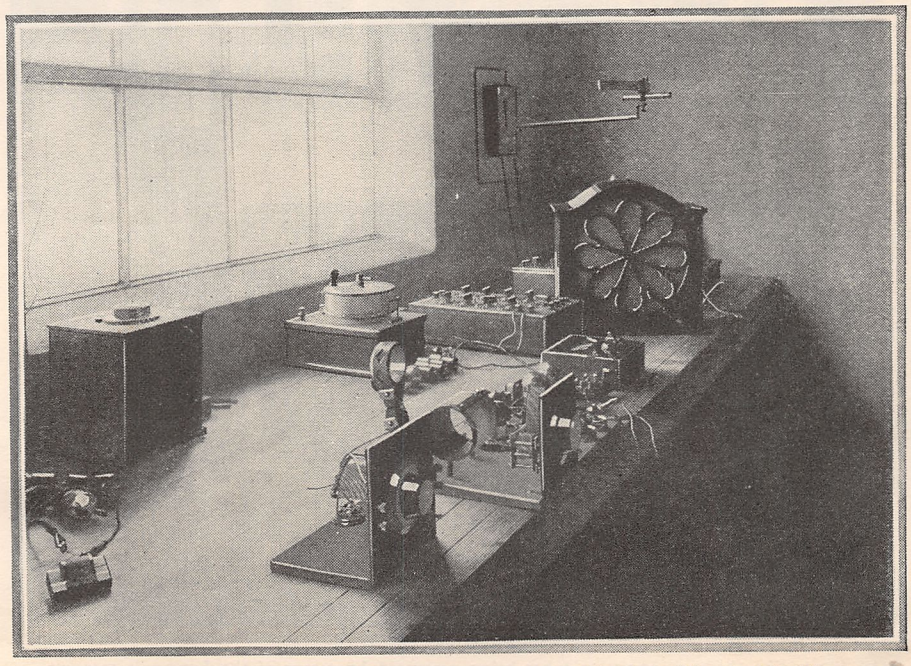


These curves show that the B-6 gives a greater output over most of the range than an ordinary hard detector tube.



The apparatus used for obtaining the comparison curves in Fig. 4 in Mr. Donle's laboratory.

How Radio Tubes Are Evacuated

By DR. C. B. BAZZONI*

This is the second part of an article on the various types of pumps used for obtaining high vacua in radio tubes. The first part of the article appeared in the March issue of RADIO NEWS, *and deals with the simpler types of pumps.*

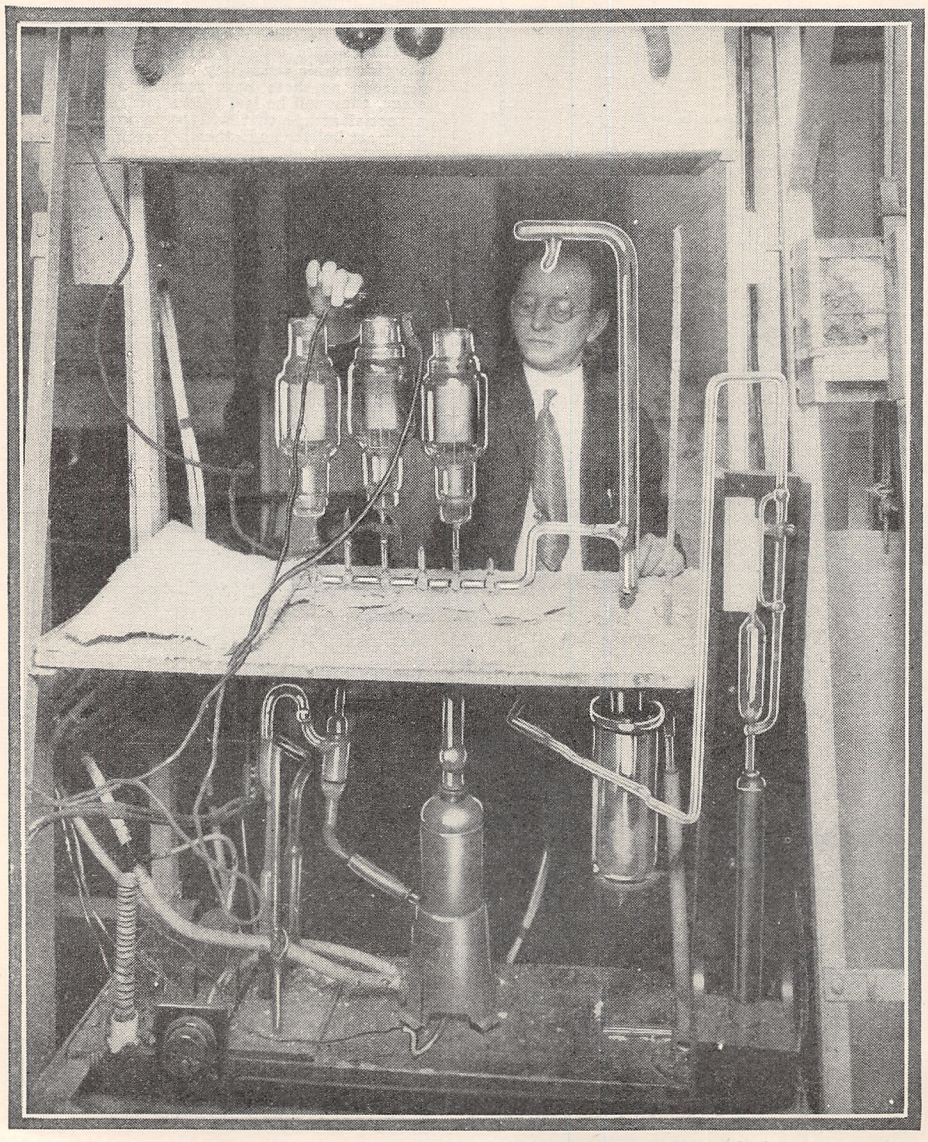
DISCUSSING, in Part 1, how to evacuate radio bulbs, we classified the various types of air pumps which are used for this purpose and described a method practical for amateurs in such work. We saw that the oil-sealed rotary mechanical pumps are the best now available for steady operation under shop conditions. These pumps, properly handled, can be depended on to give a vacuum of one one-thousandth of a millimeter of mercury, which is roughly one-millionth of the normal atmospheric pressure. Where a better vacuum than this is desired, as in most investigational work, mercury air pumps of the Sprengel pattern may be used. The Sprengel is the type of pump which we described as useful for amateurs on account of its cheapness and efficiency, but is too slow in action for the professional laboratory. The professional research worker must employ pumps belonging in Classes 6, 7 or 8 (See March RADIO NEWS, page 1282) namely, rotary mercury pumps of the Gaede pattern, mercury jet diffusion pumps of the Langmuir pattern, or rotary cylinder molecular pumps of the Holweck pattern.

Gaede's rotary mercury pump is really a high-speed continuously-acting Sprengel pump. It consists of a drum of porcelain or iron, about 8 inches in diameter, of complicated internal construction, arranged to rotate in an enclosing cylinder. Drum and cylinder are somewhat more than half full of mercury. The rate of rotation is about twenty revolutions per minute. Fig. 1A gives a side view of this pump, cut down the middle. Fig. 1B shows how the device operates. It is obvious that the construction of a drum so complicated as the one in this pump represents a triumph in the art of porcelain manufacturing—a triumph for which, naturally, a high price is charged. The air from the receptacle which is being evacuated enters through the inverted goose neck (Fig. 1A) and then passes through the hole H_1, into the chamber C. When the drum as shown rotates counter-clockwise, chamber C (Fig. 1B), increases rapidly in size. When C has passed over to the position shown in the drawing C_1, the hole H_1 is sealed under the mercury and, as the rotation is continued, the contained air is pushed along through the narrow spiral tail, being finally shoved out at E where it is taken away by an auxiliary pump. This action goes on continuously—as soon as one spiral chamber is sealed off beneath the mercury another takes its place due to the rotation.

Fig. 1A represents the actual construction of the drum, but Fig. 1B is a schematic diagram only. A distinct effort of the imagination is required to follow through the action of this pump from an inspection of the figure. When properly understood, however, the action is seen to be essentially like that of the Sprengel pump, although much faster.

It is evident from Fig. 1A that if the pressure in the delivery chamber is higher than that in the inner chamber C by more than the difference of head h (about half an inch of mercury) air will bubble in through the opening and stop the pumping action. This pump therefore requires a "fore pump" or preliminary pump in series with it. The fore pump must be able to keep the pressure in the chamber E below 1 centimeter of mercury. For this purpose a small, motor-driven, rotary oil pump, such as was described last month, can be used. These two pumps in series form a rapid and efficient system. It is possible in this way to produce a vacuum as low as .00001-mm. of mercury. Under the best conditions a five-quart bottle may be evacuated to this degree in fifteen minutes. The evacuated space will, of course, be filled with vapor of mercury, at the pressure (usually about one one-thousandth of a millimeter) corresponding to the temperature, unless means are taken to remove it. The necessary means for removing the mercury will be discussed a little later in this article.

The Gaede mercury pump is historically of great importance: since it was the first rapid-acting high-vacuum pump and since, through its use, physicists were enabled to make a number of important discoveries. Although still used sometimes in laboratories, it has been largely superseded since 1915 by pumps of Class 7—Langmuir mercury jet diffusion pumps—which are cheaper and simpler than Gaede pumps, as well as more effective. One great objection to the Gaede pump lies in the fact that more than forty pounds of mercury are necessary to fill it to the proper level.



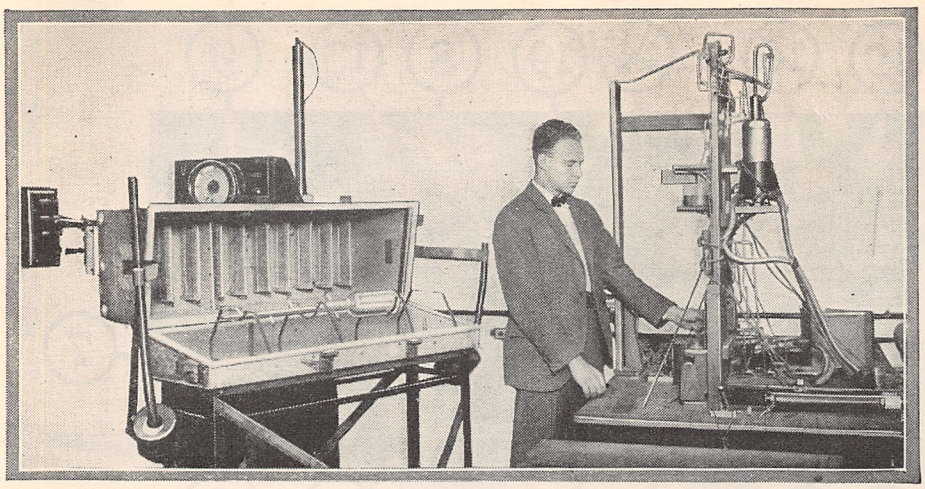
This illustration shows transmitting tubes being evacuated by means of the Langmuir mercury-vapor pump. *Photo by courtesy of the General Electric Co.*

THE JET CONDENSATION PUMP

We have referred for descriptive purposes to the Langmuir pattern of pump as a "mercury-jet diffusion pump." However, speaking strictly, Langmuir's pump is best called a "mercury-jet condensation pump," the term "diffusion pump" being reserved for a pump of a somewhat different type which we shall not describe here. Fig. 2 shows the earliest pattern of condensation pump described by Langmuir. The pipe E is to be connected to a fore pump capable of producing a pressure as low as .01-mm., such as one of the motor-driven rotary oil pumps. The vessel which is to be evacuated is attached at R. In the flask A is a small quantity of mercury—less than a pound—which can be heated from below by a gas flame or electrical heater. Under the reduced pressure produced by the fore pump the mercury boils readily, the molecules flying off with very high speeds, because there are few air molecules to interfere with their motions.

As a result of this action a stream of vapor, consisting of high speed mercury

*Professor of Experimental Physics, University of Pennsylvania.



An elaborate vacuum pumping system is maintained by the Bureau of Standards in Washington, for experimenting with radio and other vacuum tubes.

© *Harris & Ewing.*

molecules, is produced upward through the tube B. This stream shoots out into the space C, where much of it is condensed against the water cooled walls. The remainder of the vapor passes up into D and condenses there. The condensed mercury is returned to A through the side drain tubes without loss so that the same mercury is used indefinitely.

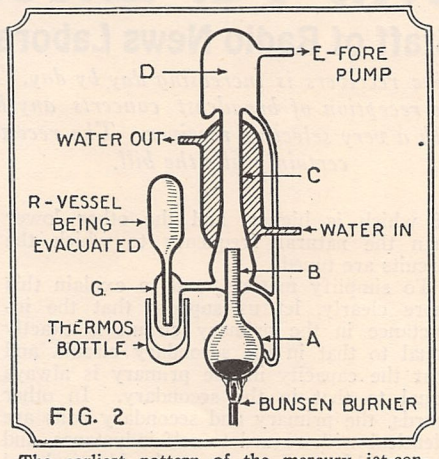
MECHANICS OF GASES

In order to understand the action of this pump it must be recalled that the molecules of all gases and vapors are moving about with an irregular, haphazard motion the average speed of which is very high. Since the heat energy of the gas is resident in this motion, the value of the average speed depends on the temperature, but even at ordinary temperatures an average speed of 35 miles per second may be reached. The average distance traversed, before the motion of a molecule is terminated by collision with another molecule, naturally depends on the number of molecules present in the space, that is to say, on the pressure—the lower the pressure the greater the average distance traveled. It is evident that as a result of this irregular motion the molecules in the vessel being evacuated will, all, sooner or later, shoot up to and through the opening around the top of tube B. Under ordinary conditions this would not cause the pressure R to become less—since as many molecules would work in through the opening on the average as worked out.

When, however, the mercury jet is in operation filling the tube C with an enormous number of upward moving, heavy, projectile molecules all the gas molecules coming out are swept upward but no molecules (or very few) can work downward. Thus the receptacle R is gradually robbed of its molecules. It is evident from this explanation that, in the long run, every one of the molecules might conceivably be thus removed from R. This type of pump is, therefore, theoretically superior to the types which we have described earlier in this article, for in them the evacuation depends on successive expansions of the air in the container and some air must always be left there as a residue.

The action of the condensation pump is not so entirely mechanical as has been indicated above. The efficiency of the evacuation is connected in some way with the rapidity and completeness of the condensation of the mercury on the walls of the tube. This point is not one into which it is necessary to enter at this point.

Mercury condensation pumps have been made in a great variety of patterns. All are however in essentials like the one shown in Fig. 2. Some are built of metal—welded sheet steel being used for this purpose because iron is not acted on by mercury—but most are made of a special glass. Glass pumps of this type can be bought at prices ranging from $12 to $30. In order to use condensation pumps, a forepump with motor is necessary, as we have already said, costing about $85. The combination, at about $100, gives its possessor a vacuum system of the highest class, capable of producing very rapidly the vacua used in any radio tube on the market. Such a system, properly handled, will produce a vacuum of .000001-mm. For the very highest vacua the art of handling is, of course, not too simple—skill and experience are required.



The earliest pattern of the mercury jet-condensation pump, which was developed by Langmuir.

FREEZING THE MERCURY VAPOR

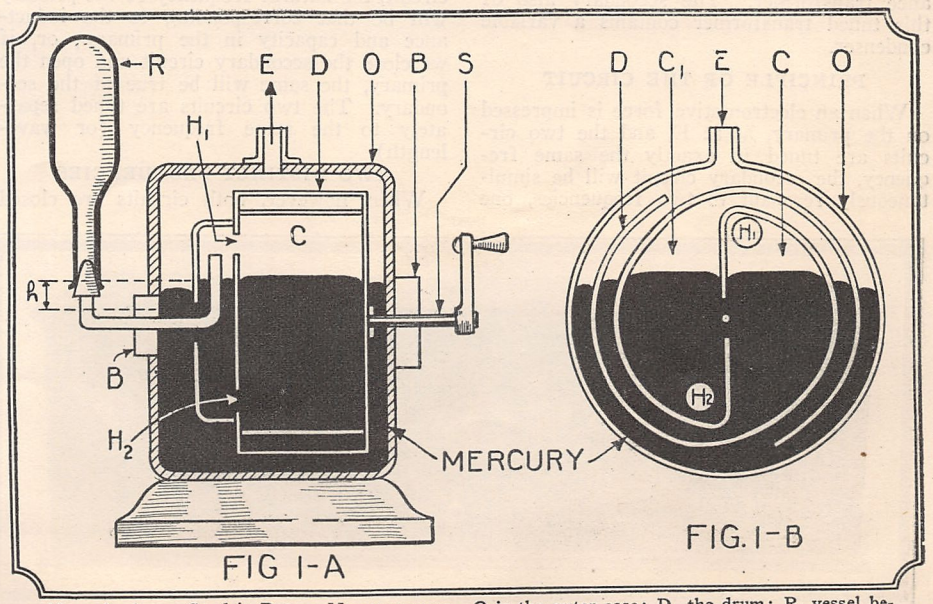
Since the mercury in this device is hot, it becomes more necessary than before to take steps to get rid of mercury vapor from the evacuated vessel. If this is not done very low pressures cannot be reached. The easiest way to remove the mercury vapor is to freeze it out. This can be accomplished by putting a freezing mixture, contained in a pint thermos flask, on the glass trap G (Fig. 2). If nothing better is available salt and ice (1 part by weight of salt to 2 parts of ice) properly crushed together may be used giving a temperature of 0° Fahrenheit. At this temperature the pressure of the mercury vapor will be .00003-mm., which is low enough for many purposes. The pressure of water vapor at this temperature, however, is nearly a millimeter so that great precaution must be taken to absorb the water vapor, which is always present. This can be done with phosphorous anhydride, a white powder with an intense affinity for water, which can be placed in a bulb attached to the pump or to the vessel being pumped out. In laboratories it is customary to use liquid air in a thermos flask on trap G, instead of salt and ice. The liquid air evaporating in the bottle will produce a temperature of about 300° Fahrenheit, at which the pressures of both mercury vapor and water vapor are so low as to be imperceptible. A vacuum obtained in this way through the use of liquid air is generally called a "liquid-air vacuum"—a term frequently seen in scientific literature.

The mercury vapor condensation pump not only produces very low vacua, but also works very rapidly. Its speed may be as much as twenty times as great as that of the rotating Gaede pump, or even greater under the best conditions of operation. In order to get first-class results in evacuating radio bulbs with such an outfit, the greatest care must be taken to have all connections made tight with sealing wax as described in our last article and also to use heat judiciously on the bulbs and on all the glass parts of the outfit during the pumping down.

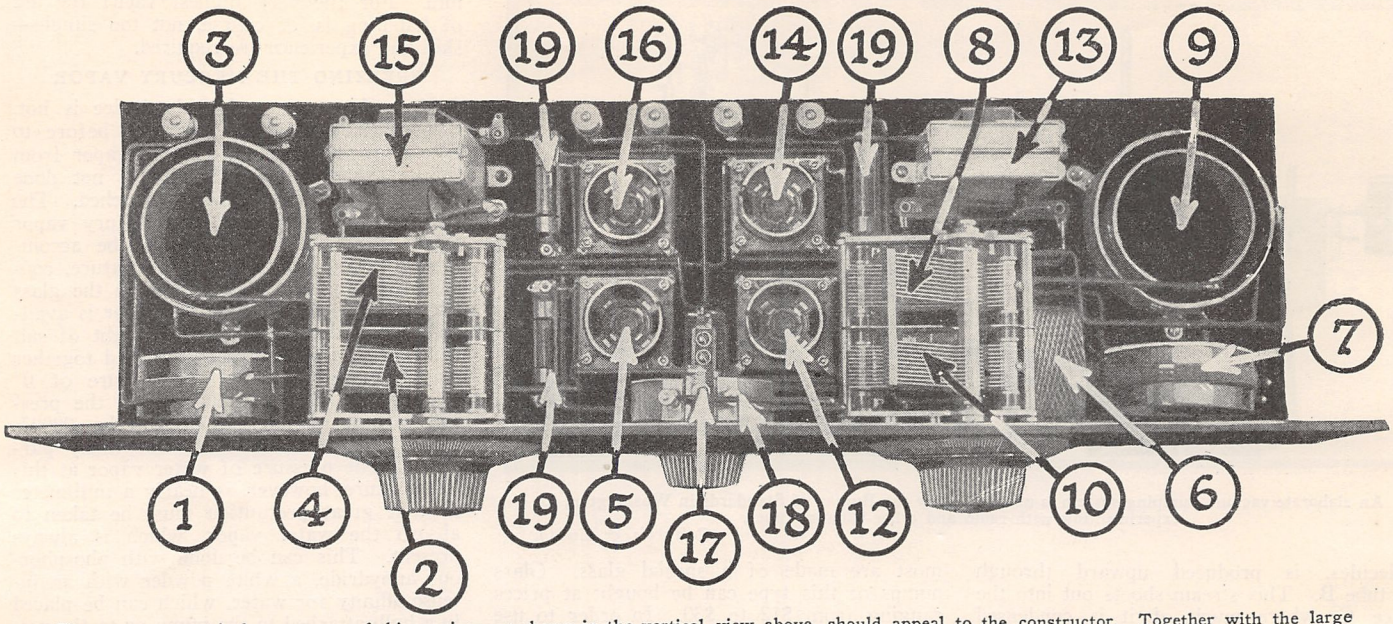
MOLECULAR PUMPS

We now come to the description of pumps of Class 8—molecular pumps. These instruments are of great interest, because of the peculiar principle on which they work, and because of their speed, efficiency and cer-

(*Continued on page* 1580)



Above is shown Gaede's Rotary Mercury pump. O is the outer case; D, the drum; R, vessel being evacuated; S, shaft; and B, sealed stuffing boxes. The other letters are explained in the text on the preceding page.



The neat, symmetrical appearance of this receiver, as shown in the vertical view above, should appeal to the constructor. Together with the large diagram on page 1553, showing every connection, this will make the task of layout simple. The numbers on the illustrations and the wiring diagram correspond to those given in the index under the big schematic diagram on the facing page.

Selectivity Par Excellence

By the Staff of Radio News Laboratories

The demand for ultra-selective receivers is increasing day by day. The congestion of the ether lanes in large cities makes the reception of broadcast concerts anything but enjoyable, unless the listener-in is equipped with a very selective receiver. The receiver described in this article certainly fills the bill.

IN the March issue of RADIO NEWS a new type of receiver was explained, in an article by Sylvan Harris entitled "An Automatic Double-Range Receiver" (page 1287). The principles involved in the design and operation of this receiver are not exactly new; they have been known for a long time, but we feel sure that this is the first time the principles of closely-coupled circuits have been utilized in radio receivers for broadcast reception.

The operation of that receiver depended upon the phenomena attached to the elementary circuit shown in Fig. 1. This figure shows an alternating-current generator, E, connected in series with a variable condenser and the primary of a closely-coupled resonance transformer. The secondary also of this tuned transformer contains a variable condenser.

PRINCIPLE OF THE CIRCUIT

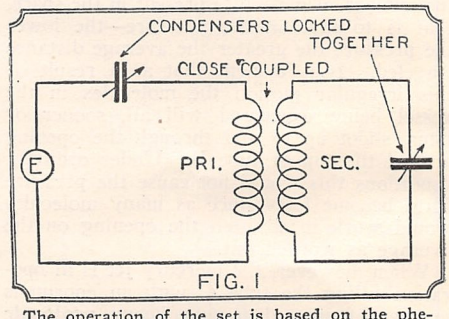
When an electromotive force is impressed on the primary, as at E, and the two circuits are tuned to exactly the same frequency, the secondary circuit will be simultaneously resonant to two frequencies, one of which is higher, and the other lower than the natural frequency to which the circuits are tuned.

To simplify matters, and to explain this more clearly, let us suppose that the inductance in the primary circuit is exactly equal to that in the secondary circuit, and that the capacity in the primary is always equal to that in the secondary. In other words, the primary and secondary coils are identical with regard to self-inductance, and the variable condensers are also identical and worked on the same shaft and by means of the same dial.

The two circuits will always, then, be tuned to the same natural frequency separately. That is, if we open the secondary circuit, the natural frequency of the primary will be that corresponding to the inductance and capacity in the primary; or, if we close the secondary circuit and open the primary, the same will be true of the secondary. The two circuits are tuned separately to the same frequency (or wavelength).

TWO DISTINCT FREQUENCIES

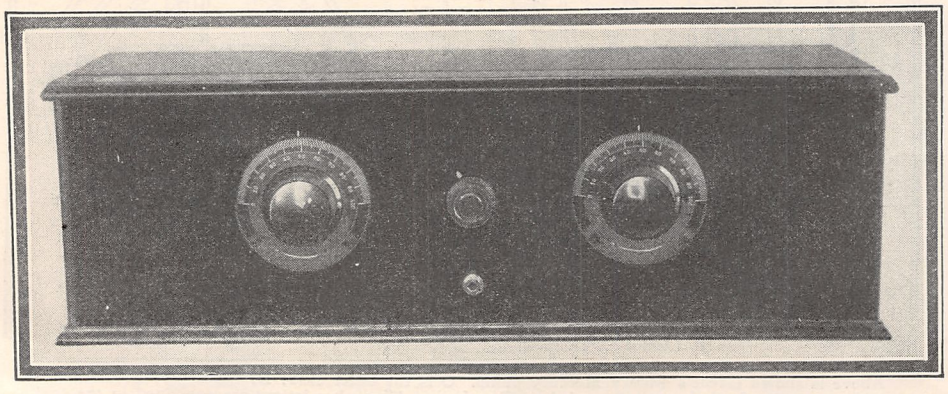
When, however, both circuits are closed (on account of the mutual inductance existing between the primary and secondary, and without going very deeply into the complicated theory) it will be found that the frequency at which the current is greatest



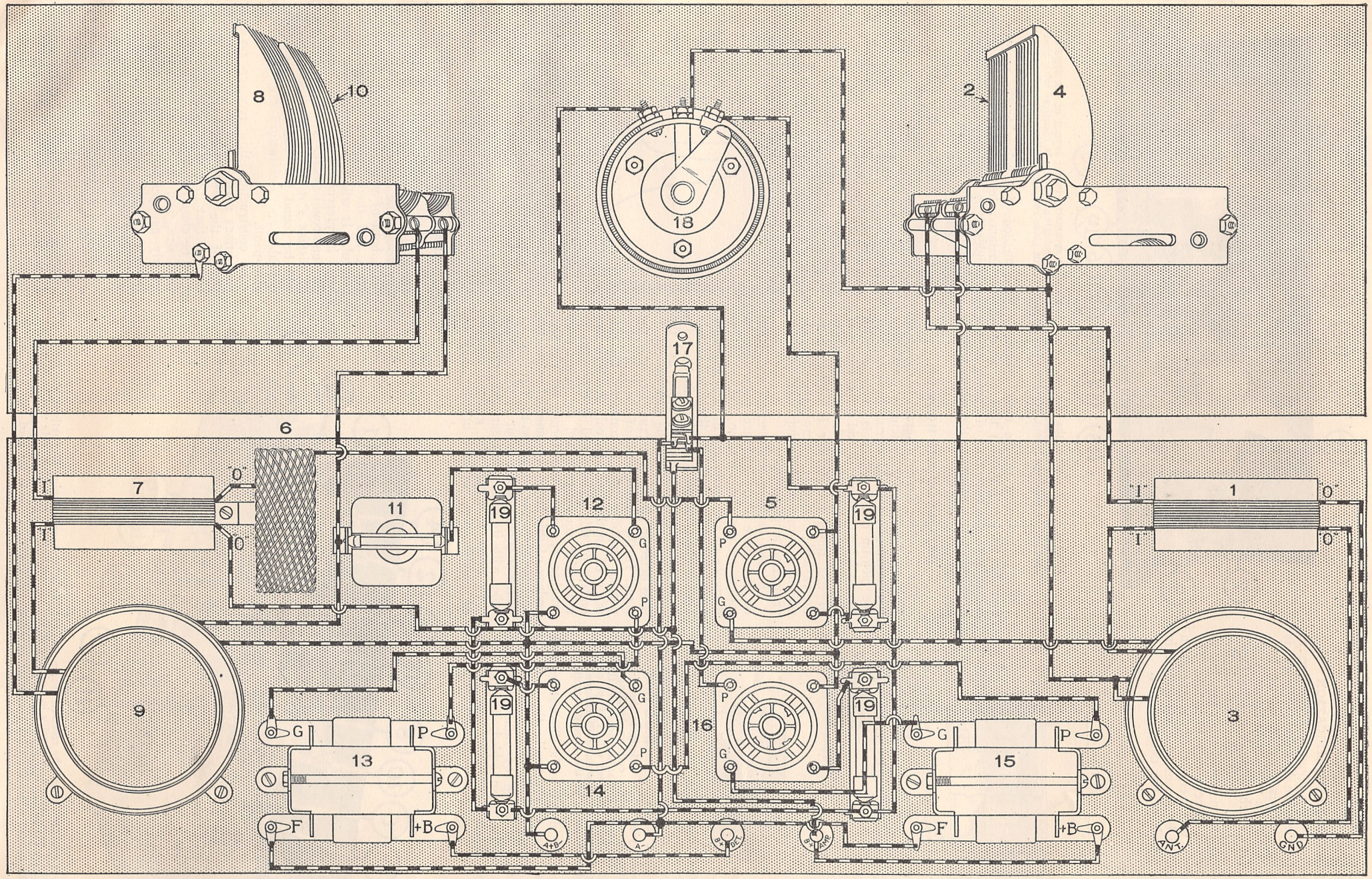
The operation of the set is based on the phenomena in the coupled circuits shown here. The secondary becomes resonant to two different frequencies, on account of the coupling.

in the secondary is not the same as we determined before, when taking into account merely the constants of either circuit by itself. If we start with a low frequency in the generator, and gradually increase it, we will find a phenomenon which can be represented somewhat as shown in Fig. 2. For a constant voltage impressed on the primary, the current will have its greatest values at the two different frequencies, f_1 and f_2, both of which differ from the natural frequency of the circuits taken separately. This natural frequency is indicated by f_0.

This phenomenon was utilized in connection with the receiver above mentioned, with the result that an automatic double-range receiver was evolved. All that it was necessary to do was to replace the generator in the primary circuit by a small pick-up coil inductively connected to the antenna system, as shown in Fig. 3. The two condensers are mounted on the same shaft, so that in spite of the fact, that we have an inter-



Besides its selectivity, this receiver is admirable for its simplicity. As the front-panel view shows, there are only two tuning controls, which log identically, and a potentiometer.

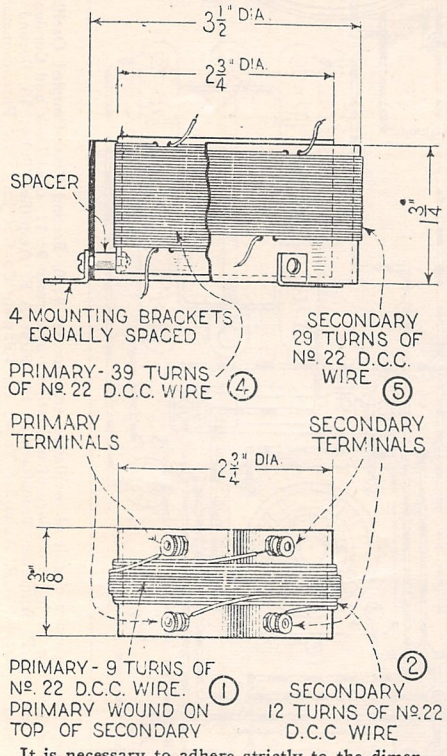


The Schematic Layout of the Receiver: 1, Antenna Coupling Coil; 2, Intermediate Tuning Condenser; 3, First Close-Coupled Oscillation Transformer; 4, Condenser for tuning secondary of oscillation transformer 3; 5, Radio-Frequency Amplifier; 6, Loading Inductance in plate circuit of 5; 7, Second Pick-Up Coil for coupling R.F. amplifier plate circuit to the intermediate tuning circuit of detector; 8, Condenser for tuning primary circuit of oscillation transformer 9; 9, Second Close-Coupled Oscillation Transformer; 10, Condenser for tuning secondary of oscillation transformer 9; 11, Grid-Leak and Condenser; 12, Detector Tube; 13, First A.F. Amplifier Transformer; 14, First A.F. Amplifier Tube; 15, Second A.F. Amplifier Transformer; 16, Second A.F. Amplifier Tube; 17, Filament-Control Jack; 18, Potentiometer; 19, Automatic Fil. Resistances.

mediate tuned circuit, there is no addition to the number of controls.

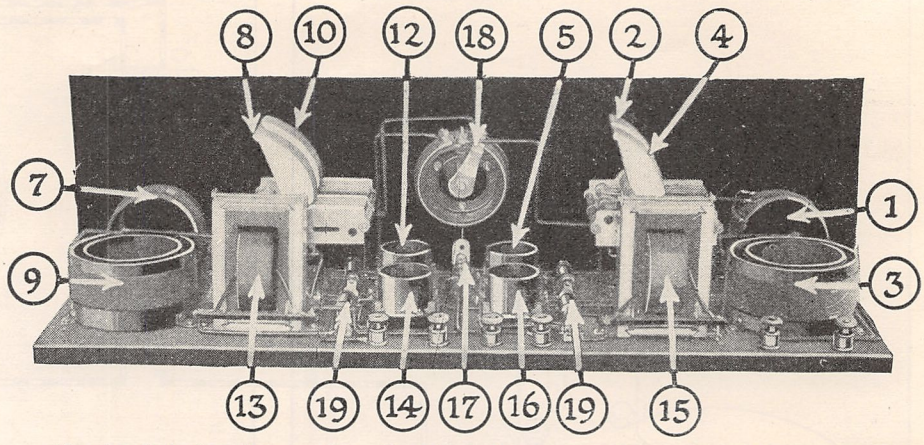
ADDED R.-F. AMPLIFICATION

The main feature about this receiver, at least as concerns the broadcast listener, is its selectivity. It is possible, as we have often done with this receiver in RADIO NEWS laboratory, to reach through all the locals in pulling in DX. It is about as selective a receiver as anyone could wish for, but in spite of this it is very easy to handle. The amplification was very good, regeneration being obtained by means of a variometer in the plate circuit of the detector tube.



It is necessary to adhere strictly to the dimensions given here for the coils in building this receiver. The reason is that any departure therefrom will result in different values of the coupling between the coils, which will change the wave-length range of the tuning circuits.

The receiver shown in the illustrations and diagrams here, is practically the same as the one previously described, with the exception that a stage of radio frequency amplification has been added, in order to make the distance-range of the receiver greater.



Here is a back view of the receiver. There is absolute symmetry in the layout of the apparatus, as well as in the appearance of the panel. The numbering scheme is identical with that used on the full-page layout. Note the arrangement of the close-coupled oscillation transformers.

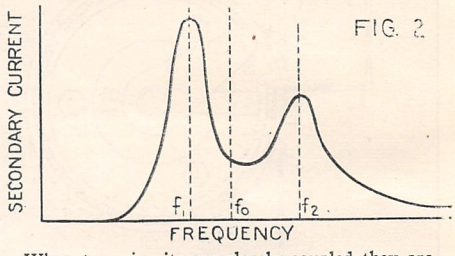
The arrangement of the radio frequency amplifier is identical with that of the detector, with the exception, of course, of the grid-leak and condenser, the plate voltage and the grid return.

DETAILS OF THE HOOK-UP

The complete circuit diagram is shown in Fig. 4. The antenna system is coupled to the intermediate tuned circuit by means of the pick-up coil 1, which is in series with the variable condenser 2 and the primary of the resonance transformer 3. The secondary of this tuned transformer is connected to the variable condenser 4, across the terminals of which is connected the input of the radio frequency amplifier tube.

The two variable condensers 2 and 4 are on the same shaft and are controlled by means of the same vernier dial. The inductance of the secondary of the resonance transformer 3 is equal to the total inductance in the primary, which includes the self-inductance of the primary winding and the secondary inductance of the pick-up coil 1. The detector circuit is arranged exactly the same. In the plate circuit of the radio frequency amplifier tube is connected the primary of another pick-up coil, 7. The secondary of this pick-up coil is connected to a variable condenser 8 and the primary of another resonance transformer 9; the secondary of this latter is connected to another variable condenser 10, across the terminals of which is connected the input of the detector tube, with its grid condenser and grid-leak.

In order to obtain the greatest amount of amplification, without utilizing any of the methods for balancing the systems, as for instance the neutrodyne or the isofarad principles, it is necessary to be able to control oscillations in the radio frequency stage. This is done by the potentiometer 18, shown in the diagrams. At the same time, since it was found that all the self-oscillation was due to the detector stage and not to the R.F. amplifier, it became evident that maximum amplification was not being obtained in the R.F. tube. For this reason, therefore, a loading inductance was placed in the plate circuit of the first R.F. tube. This loading inductance, 6, was made of such value that this circuit would just be on the verge of oscillation at the shortest wave-length it was desired to receive. By so doing the amplification, and the distance-getting qualities of the receiver, were considerably enhanced.

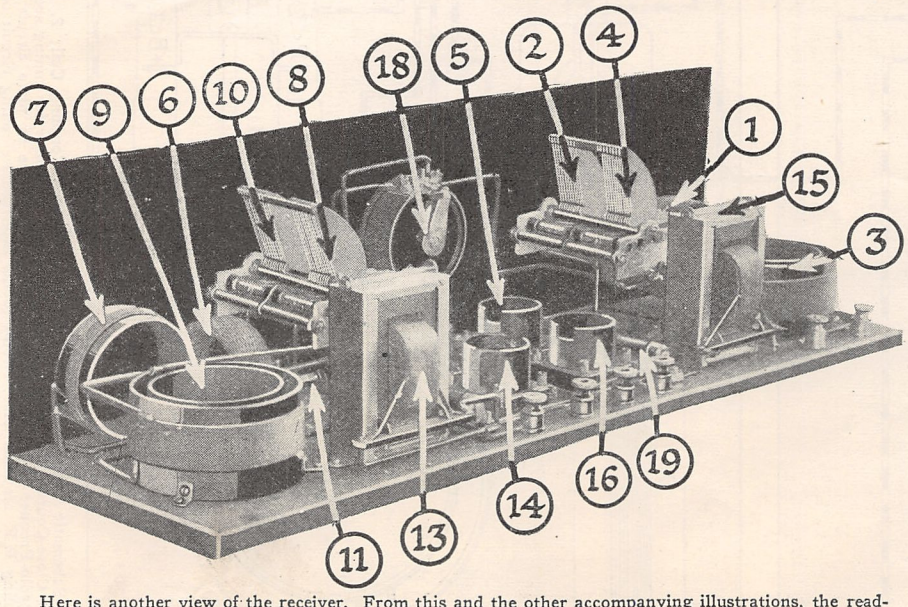


When two circuits are closely coupled they are resonant to two different frequencies, one higher and one lower than the natural frequency of the circuits. These two frequencies are sufficiently separated by the closeness of the coupling so that there is no possibility of confusion.

SIMPLICITY AND SELECTIVITY

It will be found that this receiver is about as selective as anyone can handle with any reasonable facility. There are only two dials, both of which always read about the same, and there is also the potentiometer control. It will tune through any kind of local interference, and has all the volume that one could desire. It will pull in plenty of distant stations; so that, all in all, it will be found that this receiver is a very desirable and satisfactory one from every view-point.

In constructing this receiver no more precautions must be taken than in building any of the usual receivers, with the exception that the dimensions of the coils must be closely adhered to. The diameters, wire size, and number of turns must be exactly as specified in the accompanying figures, and the condensers likewise must have the capacity specified. Any departure from these specifications will change the range of the receiver, on account of the ease with which the mutual inductance of the resonance transformer may be altered, and hence the co-efficient of coupling, which helps to determine the range of the receiver.



Here is another view of the receiver. From this and the other accompanying illustrations, the reader should experience no difficulty in building it and assembling the apparatus. He will be amply repaid for his efforts, judging from the results obtained with it in RADIO NEWS LABORATORIES, located where the ether congestion is worse than anywhere else in the good old U. S. A.

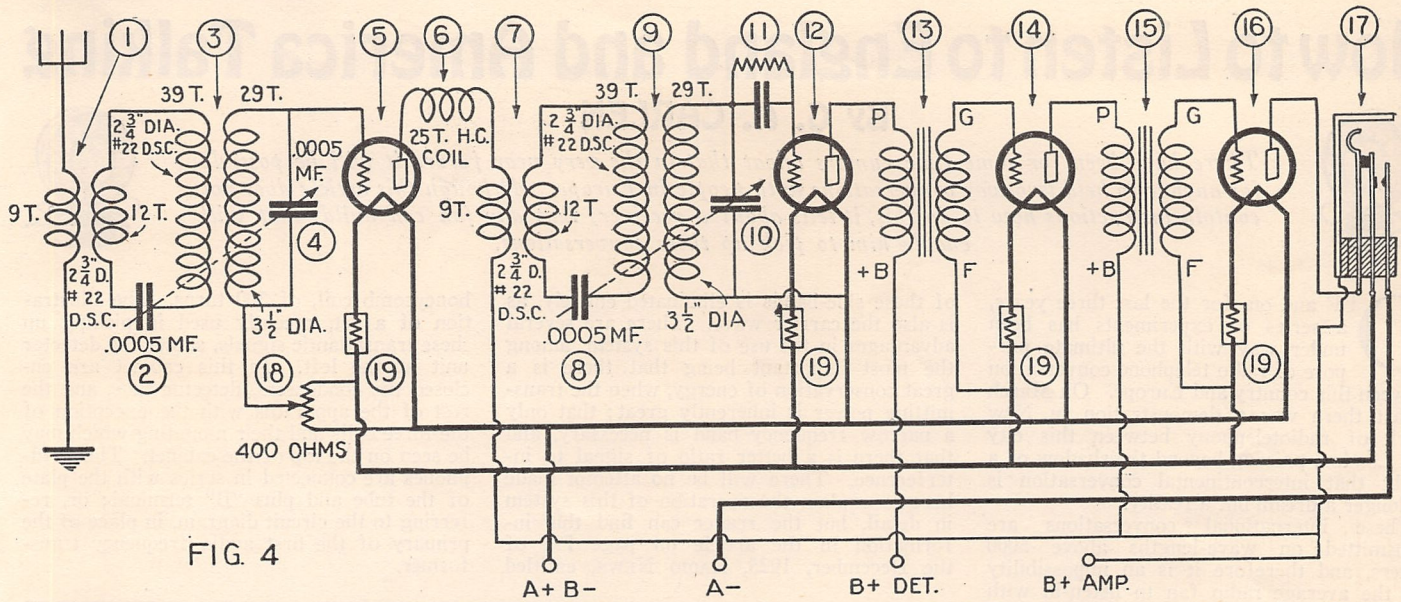


FIG. 4

The complete wiring diagram of the receiver. Note that the R.F. stage and the detector stage are identical in all respects, except in two points; the plate circuit of the R.F. amplifier is loaded with an inductance to bring the tube near the point of oscillation; and the detector circuit, of course, has its grid leak and grid condenser. The numbering scheme is the same as that used on the full page diagram and the illustrations.

As mentioned in the previous article, the adjustments of the variable condensers is not critical. The fact that they may not balance up exactly does not make it necessary to use extra midget condensers for

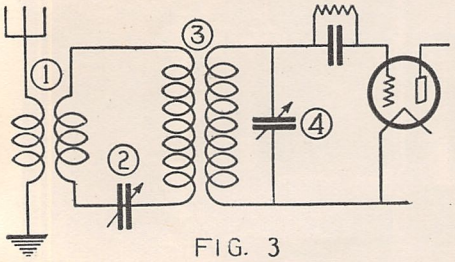


FIG. 3

The functioning of the receiver is based upon the similarity between this simple diagram and the one shown in Fig. 1. The generator shown in Fig. 1 is replaced by the antenna coupling coil (1). The numbers correspond to those on the wiring diagram.

balancing; for on account of the closeness of the coupling, any slight unbalance is automatically taken care of. In fact, it will be found that the circuits can be tuned very sharply, even when the condensers are considerably out of balance; although such excessive unbalancing will tend to make the receiver less sensitive.

BROADCAST AND AMATEUR RECEPTION

The values of the condensers and coils are given on the wiring diagram, in addition to the special diagram showing the detailed construction of the coils. As explained before, although there are two frequency ranges to this receiver, the co-efficient of coupling between the two coils of the close-coupled resonance transformer has been so adjusted that one of these ranges falls within the broadcast range of wave-lengths, while the other falls in the amateur range.

There will thus be no confusion between these two ranges, as the required adjustment for regeneration, that is, the setting of the potentiometer, will be different for the two bands. In other words, although the longer wave-lengths in the amateur range may be brought in at about the same setting as the longer broadcasting wave-length, they are easily separable; since the amount of regeneration required is different for the two frequencies.

It is possible with this receiver to tune through any local stations; and no matter how congested the ether may be in your locality, you can reach out through them. The tuning is very easy, no more fine control being required than that furnished by the ordinary vernier dial. And the sensitivity of the receiver and the volume obtained from it are comparable with those of any other well-designed radio receiver.

IT is against the policy of RADIO NEWS to publish the names of manufacturers or makes of instruments in connection with the apparatus described in these pages, but this information will be gladly given privately. If you are interested in any special instruments described here, address a letter to the I WANT TO KNOW DEPARTMENT, enclosing stamped return envelope. The names and addresses of the manufacturers will be given free of charge. —EDITOR.

Why the Counterpoise?

By WM. J. CUMMINGS, 1 ABP

THE counterpoise has long been a subject of discussion. It is the one thing that the amateur, that is, the brasspounder, has always felt was an evil necessity, but is it? How many of us have tried transmitting without a counterpoise? The single wire antenna for transmitting has, of course, become well known and works efficiently, although theoretically it is not of the best design.

To every live amateur experimenting or operating on low waves, and to those contemplating the use of low waves, especially the 20- and 40-meter bands, the following will doubtless prove profitable reading, for most of us are situated so as to be able to erect a fairly efficient antenna system, but the counterpoise problem has always been a real one. There are innumerable obstacles to prevent the erection of a good counterpoise almost everywhere and perhaps no one knows it better than the ham who has been confronted with the problem of erecting an efficient one. But let us say now that his troubles are of the past, for excellent results can be obtained without a counterpoise.

After hearing some discussions on the subject the writer decided to find out for himself and has reached the conclusion that a counterpoise is, or at least should be, a thing of the past ages. It is, in the writer's opinion, a waste of time and money to erect one, for better results have been obtained, not only at the writer's station but also at the stations of several of his friends, without one.

The circuit is of the conventional coupled Hartley style with the grid leak connected from grid to filament.

The best DX at the writer's station using a counterpoise was working Europe, but since the use of the counterpoise has been done away with, DX has not only increased but it is possible to work good DX more easily and more consistently. The only essential things are a variable grid and plate condenser of .00025 and .005 capacities, respectively. The adjustment of the variable grid condenser has a great deal to do with the note, and it is the experience of the writer that for best results the clip on the antenna coil should be adjusted until the circuit draws the most mils. The theory that the no-load mils should be comparatively low for best efficiency explodes with this circuit for, at the writer's station, European and South American stations have been worked with the no-load mils *higher* than the load mils, and certainly to work a station from 3,000 to 4,500 miles away is proof enough that the circuit is working efficiently.

Since using the circuit in question, DX at the writer's station has increased so that practically all of the United States, Canada, England, France, Denmark, Bermuda, Porto Rico, Brazil and WNP have been worked often, while reports on reception of the signals have been received from all over Europe, Ireland, Argentina and Australia.

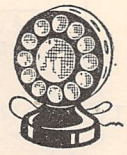
For those of us who are born experimenters the writer suggests that it would do no harm, at least, to try the counterpoiseless circuit and is of the opinion that those who try it will be rewarded with surprising results. It has also been noted at the writer's station that, after the counterpoise had been taken down altogether, the results were much better than when the counterpoise remained up but was not in use.

Doubtless there are many who have thought and still think of transmitting and counterpoises as one and inseparable, but with the development of the counterpoiseless circuit one of the greatest problems of the transmitting amateur, that of erecting an efficient counterpoise, has been mastered in a most simple, yes, *the* most simple way—by not erecting one.

How to Listen to England and America Talking

By G. A. CARLEN

There have been for some time rumors afloat that in the very near future it will be possible for anyone to held two-way conversations with people in Europe. Although this article does not contain instructions how to do this, it tells about a receiver, that any fan can build, that will enable him to pick up these conversations.



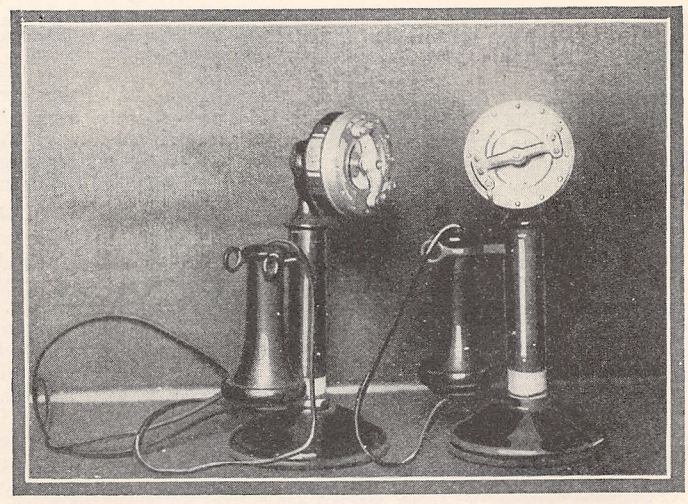
OFF and on, for the last three years, a series of experiments has been under way with the ultimate purpose of radio telephone conversation between this country and Europe. On March 7 last there was a demonstration in New York of radiotelephony between this city and London, proving beyond the shadow of a doubt that intercontinental conversation is no longer a dream but a reality.

These international conversations are transmitted on wave-lengths above 5000 meters, and therefore it is an impossibility for the average radio fan to listen-in with the set with which he hears the broadcast stations in this country. However a receiving set has been developed with which it is possible to pick up the transmissions from either side of the Atlantic Ocean. This may sound like more or less of a day dream, when it is said that it is possible to hear England on one tube and with no radio frequency amplification before the detector tube, but here is the reason why this can be done.

EFFECT OF RE-RADIATION

The American Telephone and Telegraph Co., under whose auspices this work has been conducted, has established very elaborate receiving equipment at Houlton, Me., and at Riverhead, L. I., for the reception of the transatlantic signals. There is sufficient inductive relation, between the circuits carrying the signals received from England and the circuits carrying the signals for transmission to England, to cause the English signals to be re-radiated by the American transmitter, making it quite possible to listen to both sides of the conversation. In this case the amateur in this country will receive the signals from England and the United States, but will receive them both from the local transmitter, the former by re-radiation and the latter by direct radiation.

The method of transmission employed in this system is radically different from that used by the broadcast stations. It is called a single-side-band eliminated-carrier method. Ordinarily there are two side bands used in the transmission of radio broadcasting, which are impressed on a wave of high frequency called the carrier wave. In this system one of these side-bands is eliminated entirely, as is also the carrier wave. There are several advantages in the use of this system, among the most important being that there is a great conservation of energy, when the transmitting power is inherently great; that only a narrow frequency band is necessary, and that there is a better ratio of signal to interference. There will be no attempt made here to explain the operation of this system in detail, but the reader can find this information in the article on page 790 of the December, 1925, RADIO NEWS, entitled "Trans-Atlantic Radiotelephony" by G. C. B. Rowe.



During the transatlantic two-way radiotelephone tests, the usual carbon-granule microphones were replaced by the special microphones shown in the illustration on the right. These microphones are more or less similar to those employed in the studios of radio broadcast stations.
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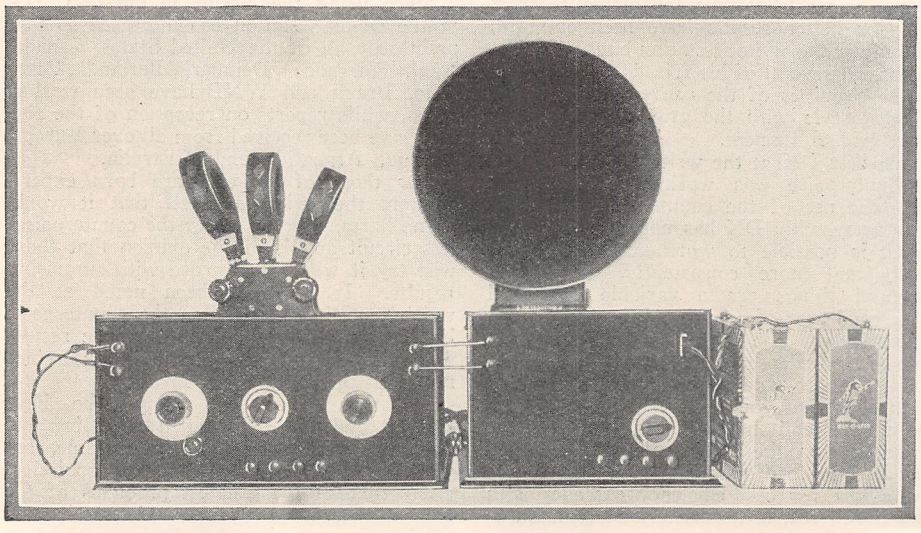
BUILDING A LONG WAVE SET

In order to listen to these most interesting —and in time to come they will be considered historical—experiments, all that is necessary is to build a very simple one-tube receiver. The list of parts for this set will be found elsewhere in this article. The primary and secondary inductance, L1 and L2, are honeycomb coils of 500 and 750 turns respectively. Each of these coils is shunted by a variable condenser, having a capacity of .0005-μf. There is a tickler coil, L3, which is also a honeycomb coil, of 300 turns. The illustration of a set, recently used in picking up these transatlantic signals, shows the detector unit at the left. In this cabinet are enclosed the condensers, detector tube, and the rest of the apparatus with the exception of the three coils and their mounting which may be seen on the top of the cabinet. The headphones are connected in series with the plate of the tube and plus "B" terminal; or, referring to the circuit diagram, in place of the primary of the first audio frequency transformer.



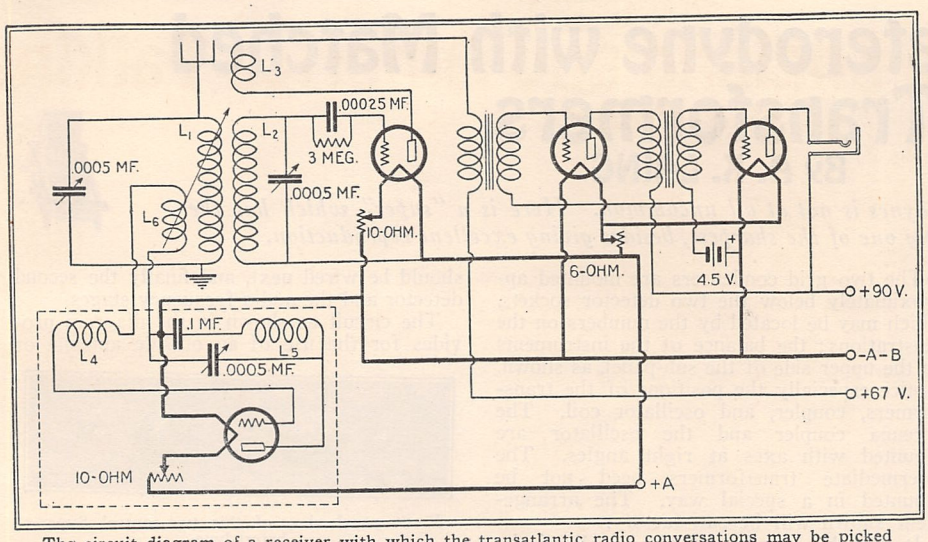
At the left is shown the unit containing the regenerative detector and next is the two-stage amplifier. The honeycomb coils are mounted on the lid of the detector cabinet.

Like all radio tuners, the results are dependent upon the skill of the operator, and this holds true to an even greater extent when trying to pull in these single-side-band signals. After the connections have been checked insert the tubes, switch on the filaments, and if the transatlantic stations are operating you can tune them in. Bring L3 close to L2 (the feed-back and grid coils respectively). You should hear the click in the phones that denotes regeneration. The American station, 2XS, which works on a wave-length of 5260 meters, should come in on the primary condenser somewhere between 40 and 50 and on the secondary condenser between 30 and 35.

The British station GBT, which works on a wave-length of 5770 meters should come in just a little above the American station. You may be able to pick up some of the transmission direct from England, but this is by no means certain, so the best thing is to try to get both signals from the Rocky Point station, 2XS.

When the signals are first heard they will doubtless be badly distorted. This is overcome by bringing the set first to a zero-beat setting and then finding the correct setting just a trifle to one side or the other of the zero beat setting. This should not take very long to ascertain.

In the diagram is shown a two-stage audio frequency amplifier; and in the illustration this amplifier appears at the right of the detector unit. This amplifier is a standard one which may be assembled from any parts that might be around the work bench, and is shown in the diagram only as a matter of convenience for the experimenter, who wishes to put these transatlantic signals on the loud speaker.



The circuit diagram of a receiver with which the transatlantic radio conversations may be picked up. In the dotted enclosure is the local oscillator, plate supply for which is shunt-fed.

OSCILLATOR IS OPTIONAL

Going back to the method of transmission, it has been stated that the carrier and one side band are removed before transmitting from the antenna system. This means that only one side band is transmitted, and for perfect reproduction at the receiving end it is necessary to supply the carrier and the missing side band.

In the wiring diagram (in the dotted enclosure) is shown the heterodyne oscillator for supplying this missing carrier. This will of course add to the quality of the signals that are manifested in the loud speaker and, if the apparatus is available for the construction of this unit, it would be well to make it up and apply it as shown. However it must be admitted that the results with it, in comparison with the results without it, are hardly enough to warrant the purchase of the additional parts; but if the parts are available it will be an interesting experiment to construct the oscillator.

The 500-turn coil, L-5, is the oscillator plate coil and the 300-turn coil, L4, is the grid coil. The oscillator is tuned by means of the .0005-μf. condenser that is connected across the plate and grid of the oscillator tube. The 25-turn coil, L6, is placed in inductive relation to the primary coil, L1, and is tapped in on the low potential side of the grid coil of the oscillator. The oscillator plate potential is supplied across the 0.1-μf. condenser, which serves the double duty of a blocking condenser and a radio frequency by-pass condenser.

The tuning of this part of the apparatus requires quite a bit of care. First, be sure that the tuner is adjusted to the wave-length of 2XS and then move the coupling coil, L6, into fairly close inductive relation to the primary coil, L1. Vary the capacity of the condenser in the oscillator circuit until the oscillator-beat note is heard. Now increase the capacity of the oscillator condenser slightly, just a hair at a time, until the beat note disappears. As a further help in calibrating the set it may be added that station WNU at New Orleans will be found above 2XS and NAU is found just below 2XS.

The list of parts for the receiver is as follows:

3 Variable Condensers, .0005-μf.,
1 Fixed Condenser, .1-μf.,
2 Honeycomb Coils, 500-turn,
2 Honeycomb Coils, 300-turn,
1 Honeycomb Coil, 750-turn,
1 Honeycomb Coil, 25-turn,
4 Tube Sockets,
2 Rheostats, 10 ohms,
1 Rheostat, 6 ohms,
2 A.F. Transformers,
1 Single-circuit Jack.

Approximate cost of parts under $20.00.

OPPORTUNITIES FOR PUBLIC SERVICE

The public tests mentioned in the first paragraph were of great interest, in that they offered the first chance to anyone outside the companies that were carrying on the experiments to participate in two-way transatlantic radiotelephony. Representatives of the press on both sides of the Atlantic were invited to attend these first public tests; and they reported that it was indeed a thrill to be talking to someone across three thousand miles of ocean.

The transmission of speech by this single-side-band system is said to be every bit as efficient as communication over the ordinary telephone with wires. In fact one man is reported to have said that he had a better "connection" with London than he often had when talking over a line measured in hundreds of miles.

Just how soon this new means of communication with England will be opened for public use is still unknown, but it seems safe to say that within the next few years we will think it no more of a miracle to call some friend in London from New York by means of the radiotelephone than we consider calling San Francisco from Manhattan today.

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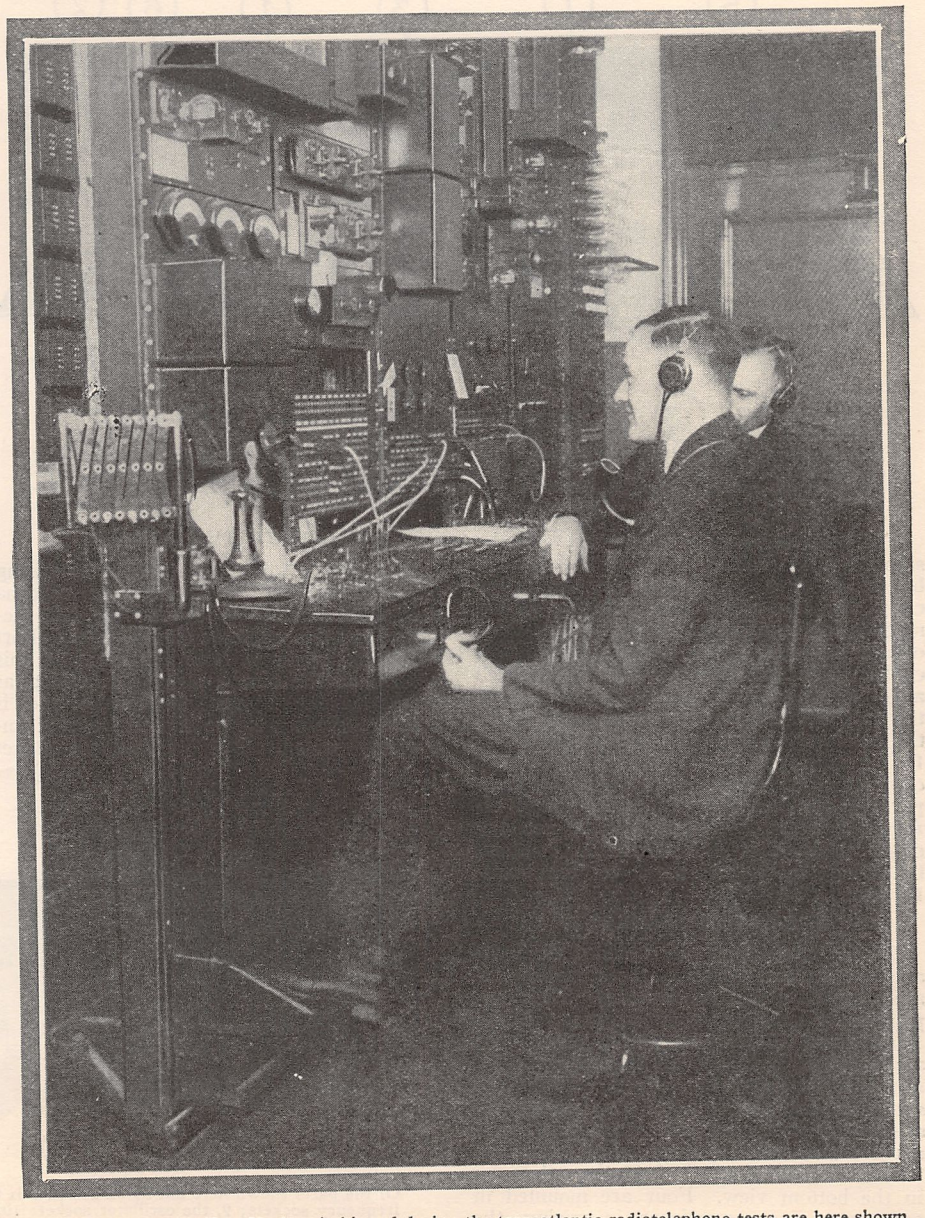
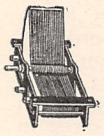
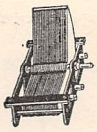


The operators at the New York switchboard during the transatlantic radiotelephone tests are here shown.
© *International Newsreel.*

A Super-Heterodyne with Matched Transformers





By A. K. LAING

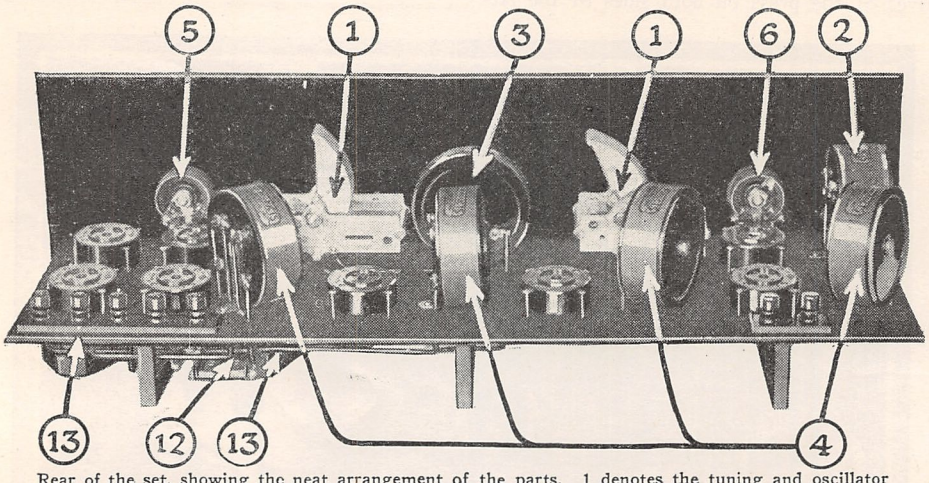
Sharp tuning in super-heterodynes is not at all uncommon. Here is a "super" which has the distinction of being one of the sharpest, besides giving excellent reproduction.

THE success or failure of any super-heterodyne receiver is dependent primarily upon its stages of intermediate frequency amplification which are, indeed, the main distinguishing feature that sets the super-heterodyne apart in the classification of receiving circuits. It is very important, therefore, to choose the intermediate frequency transformers with more than usual care. Sometimes it is necessary for the builder to match these transformers to one another, and to resort to various devices for suppressing oscillations, before the set will function properly.

In the receiver shown in the illustrations on this page the transformers are of a type matched at the factory, and provided with means for suppressing oscillation and obviating the necessity for matched tubes. These features simplify greatly the construction and adjustment of the set.

The two grid condensers are mounted approximately below the two detector sockets, which may be located by the numbers on the illustrations; the balance of the instruments on the upper side of the sub-panel, as shown. Notice especially the positions of the transformers, coupler, and oscillator coil. The antenna coupler and the oscillator are mounted with axes at right angles. The intermediate transformers need not be mounted in a special way. The arrangement shown will be satisfactory.

It will be found that almost all of the wiring can be done below the sub-panel. It is unwise, however, to run a lead down and then up again, in cases where its length can be shortened by fifty per cent. or more by running it direct. By inspecting the wiring diagram and the photographs reproduced on this page it should not be difficult even for the novice to connect up the instruments in this super-heterodyne receiver.



Rear of the set, showing the neat arrangement of the parts. 1 denotes the tuning and oscillator condensers; 2, the antenna coupler; 3, the oscillator transformer; 4, the tuned intermediate-frequency transformers; 5, the potentiometer; 6, the second detector rheostat; 12 and 13, the under-slung audio-frequency transformers.

The transformers are air-wound, and the secondary of each is tuned at the factory by means of a small condenser inside the case. By this means the frequency of the secondaries is adjusted to within one-third of one per cent. of the proper value, 88,000 cycles. The primaries are aperiodic, which aids in suppressing oscillations. Due to the fact that a condenser is shunted across the secondary winding of each transformer, for tuning purposes, the grid-filament capacity of the tube itself is small in comparison, and has a negligible de-tuning effect. It is possible, therefore, to use any good tubes that are available, without bothering to match them to the transformers.

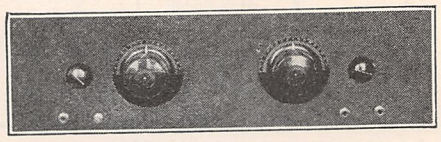
DETAILS OF ASSEMBLY

On the front panel are mounted the variable condensers, rheostat, three jacks, filament switch, and potentiometer. Their approximate locations may be seen in the front panel illustration. This scheme of arrangement need not be followed rigidly, but will be found convenient. Under the sub-panel are mounted the two audio frequency transformers, the two grid condensers and leaks, and the seven amperites. The arrangement of the latter may be seen in the bottom view. Four are mounted in one group for convenience in wiring, the others as shown.

HINTS TO THE BUILDER

It is best to follow the practice of wiring first the circuit comprising the antenna coupler, its tuning condenser, the first detector, and the oscillator circuit. Every effort should be made to keep the leads in this portion of the circuit short and direct, as it carries the highest frequencies and is subject therefore to the highest losses if improperly wired. The intermediate stages should be wired next, and finally the second detector and the audio frequency stages.

The circuit as shown in the diagram provides for the use of an outside antenna or a loop, as desired. The changes in the circuit from one to the other are made automatically by inserting a plug connected to the loop in the loop jack on the panel. It will be found in practice that the average outside antenna will give only a slight increase in volume and distance over the volume and distance possible with the loop; but those who are not troubled by local interference from stations in their immediate vicinity may prefer the outside antenna because it removes one control, the directional adjustment of the loop.

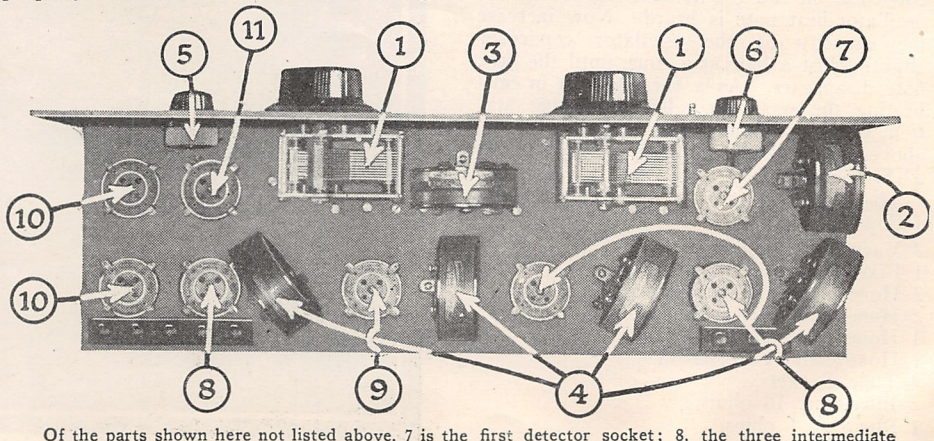


Front panel view of this two-control Super-heterodyne.

In a super-heterodyne the question of tubes is an important one. Eight tubes

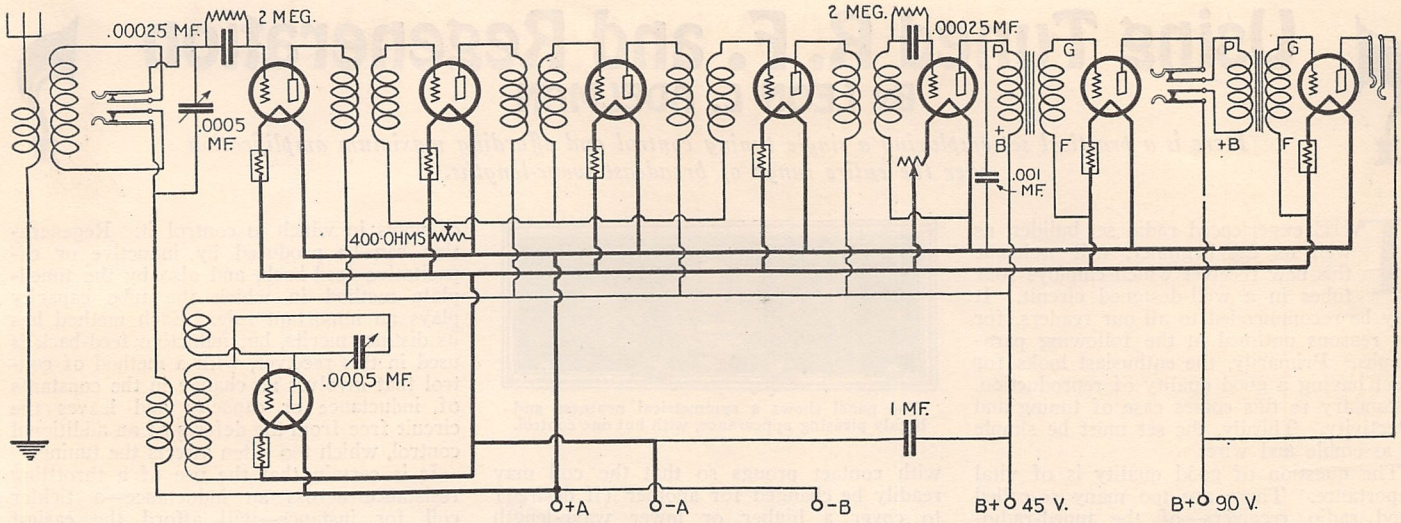
LIST OF PARTS REQUIRED

- 4 Radio Frequency Transformers, for 88,000 cycles,
- 1 Oscillator Coil,
- 1 Antenna Coupler,
- 8 Vacuum Tube Sockets, type UX,
- 2 Variable Condensers, .0005-μf.,
- 2 Grid Condensers, .00025-μf., with leak mountings, 2 Leaks, 2-megohm,
- 1 Fixed Condenser, .001-μf.,
- 1 Fixed Condenser, 1-μf.,
- 1 Potentiometer, 400-ohm,
- 1 Rheostat, 30-ohm,
- 2 Vernier Dials,
- 7 Amperites, 1-A (for 201-A tubes)
- 2 Audio frequency transformers, low ratio,
- 1 Panel 7x24x$\frac{3}{16}$ inches,
- 1 Sub-Panel 7x23x$\frac{3}{16}$ inches,
- 3 Panel Brackets,
- 2 Double-circuit Jacks,
- 1 Single-circuit Filament Control Jack,
- 1 Filament Switch,
- 7 Binding posts, etc.



Of the parts shown here not listed above, 7 is the first detector socket; 8, the three intermediate frequency sockets; 9, the oscillator socket; 10, the two audio sockets; and 11, the second detector socket.

Photos by courtesy of Geo. W. Walker Co. (Victoreen)



The circuit employed in the super-heterodyne described in the article. The secondary of each intermediate-frequency transformer is shunted by a small condenser and thus greatly sharpens the tuning. These are not shown in the diagram. Either antenna or loop can be used.

of any type cause quite a drain on the appropriate type of battery, whether wet or dry. The writer's experience shows that it is advisable whenever possible to use storage battery tubes, such as the UV-201A type, or some other reliable make with the same characteristics. With these tubes it will be found possible in most localities to bring in stations two thousand miles and more away at full loud speaker volume.

If it is necessary, however, the 199 dry cell tubes may be substituted. These will give about the same maximum range as the storage battery type, but will not deliver the volume. On stations up to 1000 miles, however, they will supply all that the average loud speaker can handle without distortion. If your locality is a favorable one, and the signals received from the average station are so loud as to be distorted, it will be advisable to use a power tube in the second audio frequency stage.

OPERATION

This receiver differs little in operation from other super-heterodynes. The chief distinction is its selectivity, which calls for more careful tuning than most. The use of amperites does away with the necessity of individual adjustment of the filament voltage of each tube. Only the second detector is controlled by a rheostat, and this adjustment will be found un-critical, but helpful when getting extreme DX.

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For the average station tuning may be reduced to three movements, or operations. Start by setting the oscillator dial at the approximate position at which the station should come in. Then vary the station selector dial back and forth near the same numerical reading as that of the oscillator. If no station is heard, re-set the oscillator dial two degrees above or below the original mark and again vary the station selector. Proceed in this manner until a station is heard. Set the station selector at the maximum volume point, re-tune the oscillator for best volume and clarity, which will be in "the middle of the wave." Then make the final adjustment on the selector dial.

Thus when the approximate position of a station is known, the last three operations enumerated are all that is necessary to bring it in at maximum volume.

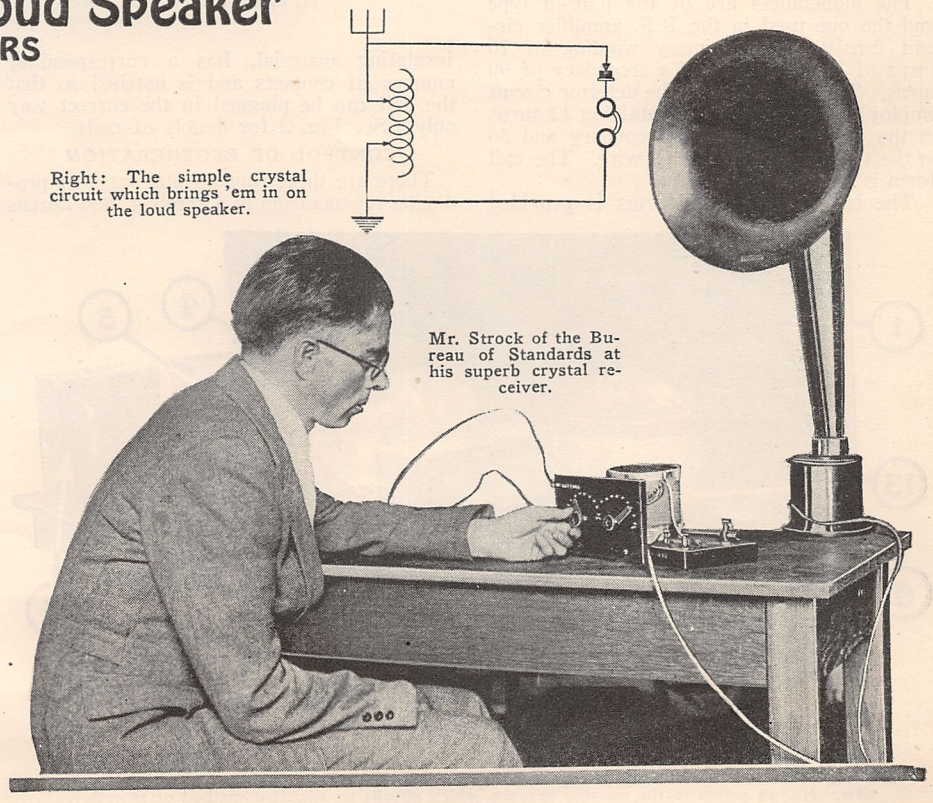
Like every other set, this one will be found to have several "tricks" of tuning, which the skilled amateur can learn by experience and put to his advantage for extreme DX. In the hands of old-time operators sets of this type can be relied upon to bring in trans-continental stations at any time when local conditions, static, etc., permit. The average broadcast listener will find it a fairly simple matter to bridge 1500 or 2000 miles, once he understands the tuning process.

Crystal Operates Loud Speaker

By S. R. WINTERS

PROBABLY ninety-nine persons out of a hundred will tell you that it is impossible to operate a loud speaker with a crystal-detector receiving set—that it simply can't be done! You are all wrong, if we are to accept the authoritative conclusion of Morris S. Strock, of the Radio Laboratory of the Bureau of Standards. He does not base his claim on mere theory, but has made experiments which have produced proof of his contention. Read what this Government radio expert has to say:

"A T-type antenna, about ninety feet high and eighty feet long, was conected to a well-designed crystal set, which was also connected to a good ground. A loud-speaking horn of efficient construction, which did not require battery power for its operation, was connected to the telephone binding post of the crystal set. This equipment was located about two and a half miles (air-line distance) from a broadcast station. When the set was properly adjusted, signals of very good volume were produced in the loud-speaking horn. These signals did not, of course, possess anything like the volume which would be obtained from a multi-tube receiving set. However, the received music and voice was very clear, and of about the same intensity as would be obtained from a type of phonograph which gives rather subdued sounds."



Right: The simple crystal circuit which brings 'em in on the loud speaker.

Mr. Strock of the Bureau of Standards at his superb crystal receiver.

Using Tuned R. F. and Regeneration

By LEON L. ADELMAN

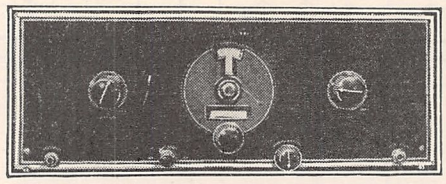
Here is a practical set employing a single tuning control and affording maximum amplification over the entire range of broadcast wave-lengths.

THE experienced radio set builder, as well as the beginner, will welcome this new receiver which employs four tubes in a well-designed circuit. It may be recommended to all our readers, for the reasons outlined in the following paragraphs. Primarily, the enthusiast looks for a set having a good quality of reproduction. Secondary to this comes ease of tuning and selectivity. Thirdly, the set must be simple to assemble and wire.

The question of good quality is of vital importance. There are too many so-called good radio receivers—of the tuned-radio-frequency type—which simply dispense the most horrible music imaginable. The reason for this is poor design in both the radio frequency stages and the audio frequency circuits. Either the tuned circuits are made too highly damped, or else so little energy is transferred from preceding stages that it it well-nigh impossible to amplify the voice currents in the audio-amplifier circuit with any semblance of fidelity. A decided lack of overtones, and harmonics is evident; and we may be sure that it is the direct result of employing irrational methods of suppressing undesirable oscillation. Then too, if the audio frequency transformers have a peak for one particular frequency, the results can be expressed not in musical terms, but rather slangily, as hash!

As for tuning and selectivity, the addition of regeneration to tuned radio frequency at once causes the amplification curve, on the entire wave-length range, to flatten out and become practically a straight line—a highly desirable feature. Thus, with one stage of tuned radio frequency and a regenerative detector, the resulting circuit gives the utmost in sensitivity and selectivity.

The last, but very important consideration has been adhered to by using the cable method of interconnection.



The panel shows a symmetrical neatness and highly pleasing appearance, with but one control.

COIL CONSTRUCTION

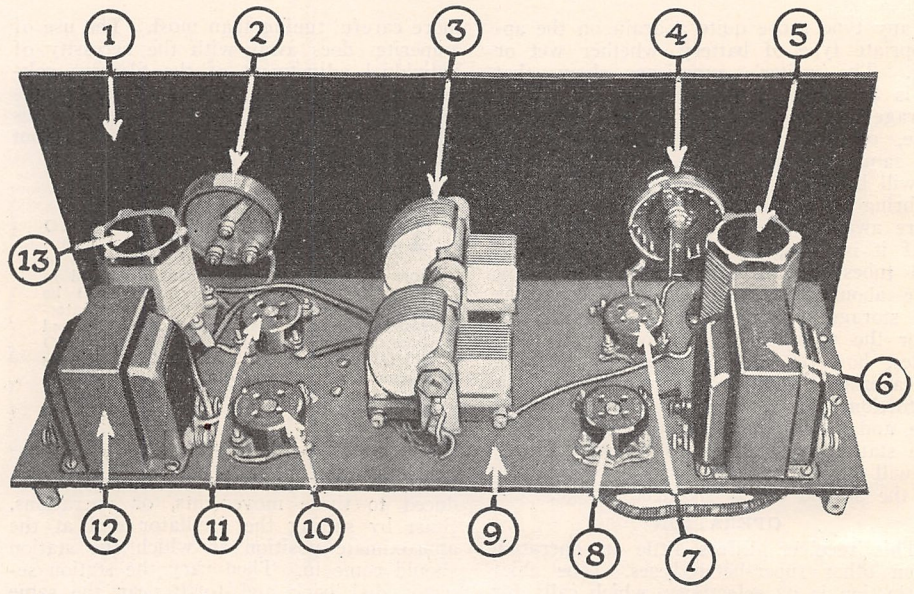
The inductances are of the plug-in type and the one used in the R.F. amplifier circuit consists of a primary winding of 16 turns of No. 28 wire and a secondary of 90 turns. The inductance in the detector circuit employs three windings—containing 12 turns in the primary, 90 in the secondary and 36 in the tickler, No. 32 D.S.C. wire. The coil form is 2 inches in diameter.

The base of the coil forms is provided with contact prongs so that the coil may readily be changed for another (if desired) to cover a higher or lower wave-length range. The circular coil mounting, of molded insulating material, has a corresponding number of contacts and is notched so that the coil can be plugged in the correct way only. See Fig. 2 for details of coils.

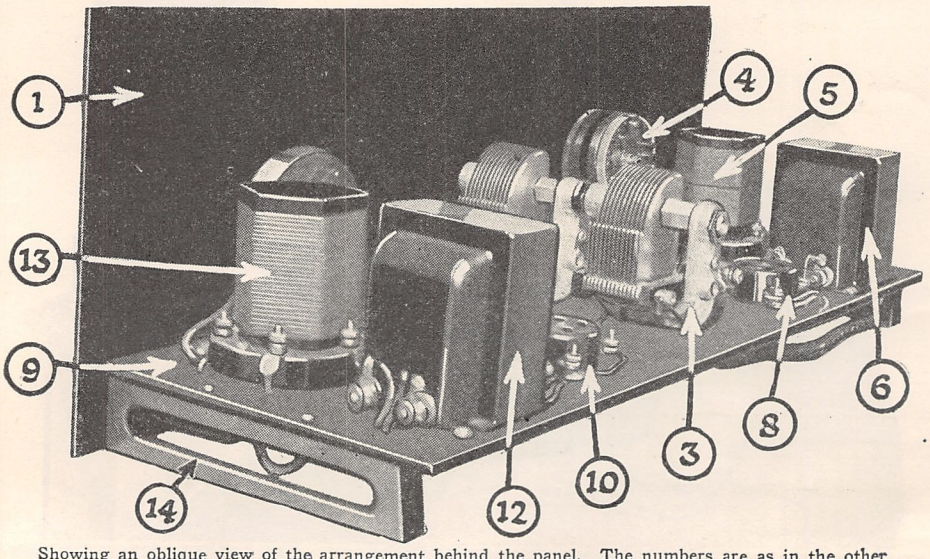
CONTROL OF REGENERATION

There are three fundamental ways of producing regeneration in a receiver, and dozens of ways in which to control it. Regeneration can be produced by inductive or capacitative feed-back, and also by the tuned-plate method in which the tube capacity plays an important role. Each method has its distinct merits, but inductive feed-back is used in this receiver, with a method of control that involves no change in the constants of inductance or capacity and leaves the circuit free from the defects of an additional control, which too often affects the tuning.

It is certain that the use of a throttling resistance across an inductance—a tickler coil for instance—will afford the easiest control of the energy flowing through it, without affecting its true inductance value. With a fixed coupling value—a relationship that among other things takes into the consideration the proximity of one coil to another, such as that of the tickler to the secondary winding—it is possible to design a circuit having a variable resistor of such a range as to allow complete control of regeneration. This has been done in this circuit by using a variable resistance with a maximum value of 25,000 ohms. Much smoother adjustment is thus obtained and the operator can get practically the same amplification over the entire range of wave-lengths. The "spillovers" and clicks, which are ordinarily too common with a variable tickler coil, are absent and the results that will accrue will far surpass expectations.



Neatness in layout is not confined to the panel, which is shown as 1; 2 is the variable resistance controlling regeneration; 3, double tuning condenser; 4, rheostat; 5, antenna inductance; 6, first audio transformer; 7, R.F. socket; 8, first audio socket; 9, baseboard; 10, second audio socket; 11, detector socket; 12, second audio transformer; 13, 3-circuit inductance.

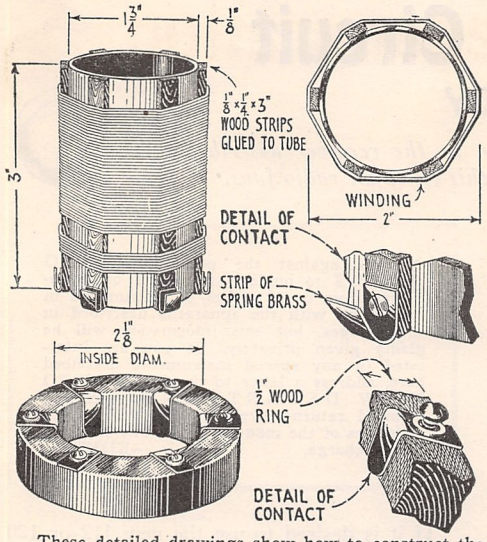


Showing an oblique view of the arrangement behind the panel. The numbers are as in the other view. No. 14 points to the metallic bracket, which affords an excellent method of assembly.
Photos by courtesy of S-C Merchandising Co., Inc.

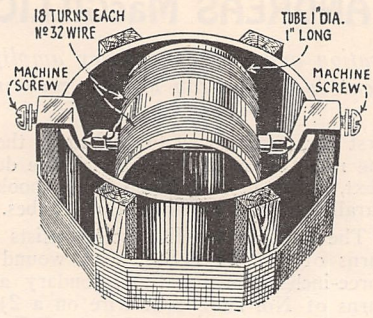
MOUNTING AND ASSEMBLY

By this time, the reader is certain to become enthused with the capabilities of this receiver, so that the list of parts necessary for its construction follows:

1 Double Condenser, .00035-μf.,
1 Midget Condenser, 45-$\mu\mu$f.,
1 Grid-Condenser, .00015-μf.,
1 By-Pass Condenser, .002-μf.,
1 By-Pass Condenser, .005-μf.,
1 Panel, 7x18 inches,
1 Sub-Panel, 6x16 inches,
2 Mounting Brackets,
2 Inductance Coils (as above),
2 Mountings for Coils,
4 Tube Sockets,



These detailed drawings show how to construct the tuning inductances, one of which has a third coil attached to one end, as shown. A wooden dowel pin, fitted with metallic end-caps from a discarded grid-leak, provides a good rotor shaft.



DETAIL OF TICKLER COIL FOR 2ND INDUCTANCE

Fig. 2.

2 Audio Transformers,
2 Jacks (see diagram for type),
1 Rheostat, 6-ohm,
1 Variable Resistance, 0-25,000-ohm,
1 Grid Leak, 2-megohm,
1 Filament Switch,
1 Vernier Dial,
1 Wiring "Harness."

With the getting together of the instruments and parts, the layout of the panel and sub-panel comes to our attention. The illustrations clearly show the exact arrangement of parts and the only wiring that is visible. These wires are the radio frequency circuits, outlined heavily in the diagram. Fig. 3, showing the underside of the sub-panel, depicts the methods of cabling the connections together. It also shows the manner in which the small midget condenser, as well as the two jacks, filament switch, by-pass condensers, grid-condenser and grid-leak are mounted.

The cable may readily be made by the builder. Ordinary bell wire, cut to the correct lengths and firmly bound together, either with tape or else by using the lock-stitch and binding with stout cord, will offer a practical solution and make a fine product. However, be careful not to include the leads which are specified as needing to be left free.

OPERATION

Having made a careful job of the wiring and soldering, and having then ascertained that no mistakes have crept in, we can connect the "A" battery and the 4½-volt "C" battery. Then, as a final precaution against short-circuits, a 60-watt electric lamp is connected in series with the negative terminal of the "B" battery. If everything is all right, the lamp may be removed or left in the circuit. On the other hand, if there is a short-circuit, the tubes will not blow out; because the lamp will not pass sufficient current. This little kink will perhaps save some expensive tubes.

The double condenser tunes both the radio frequency stage and the detector, while the midget condenser makes up for any discrepancy in tuning between these circuits. In many cases, the small condenser will need but little adjustment. If there is a hissing noise accompanying the reception of a station, decrease the resistance of the variable resistance across the tickler coil and it will be found that the music or speech will come in clearly. If great volume is not desired, the phones or loud speaker can be plugged in after the first stage of amplification.

Note that but one rheostat controls the filaments of all the tubes. Once set, no further adjustment is necessary. Volume and clarity are the earmarks of this receiver.

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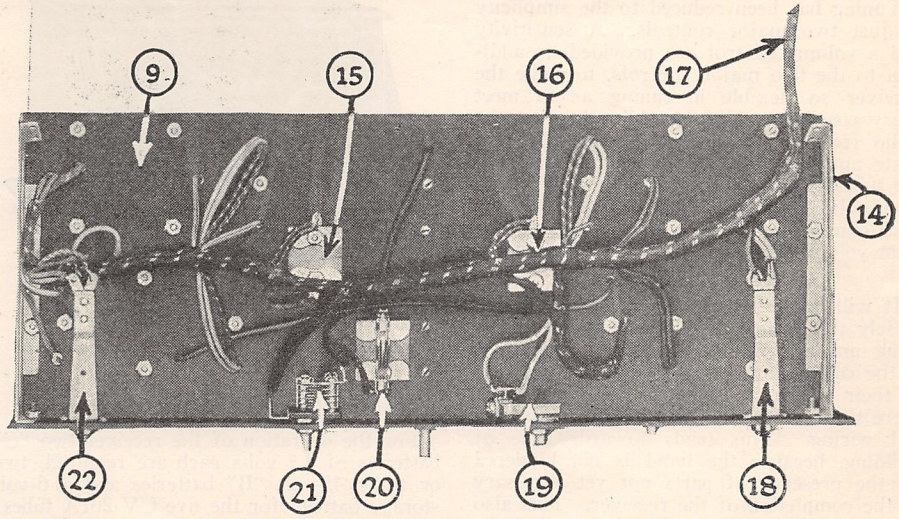
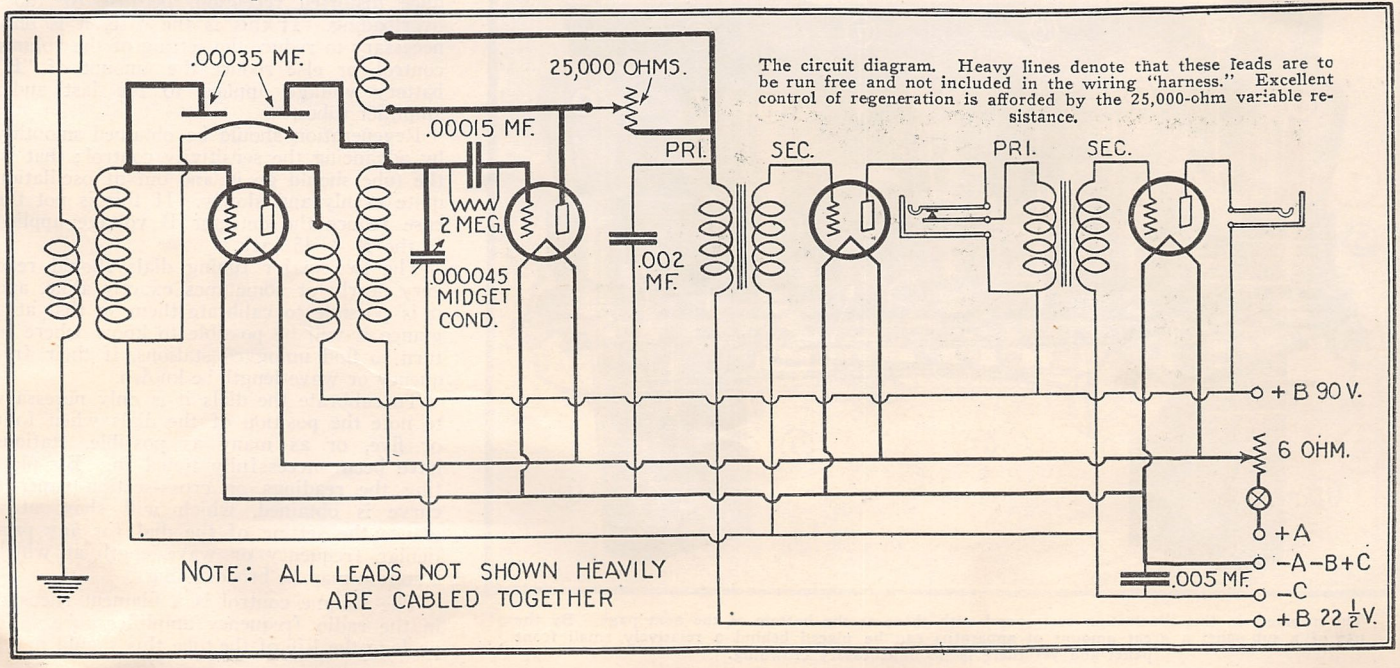


Fig. 3. A look under the baseboard convinces us of the advantages of cable wiring; 15 is a .002-μf. by-pass condenser; 16, a .005-μf. by-pass condenser; 17, wiring "harness"; 18, phone jack; 19, filament switch; 20, grid leak and grid condenser; 21, midget condenser; 22, output jack.



The circuit diagram. Heavy lines denote that these leads are to be run free and not included in the wiring "harness." Excellent control of regeneration is afforded by the 25,000-ohm variable resistance.

Building the Roberts Circuit

By ANDREAS MacGILLICUDDY

The combination of regeneration and radio frequency amplification in the receiver described in this article is an excellent one. We can heartily recommend this set to all radio fans.

THE Roberts receiver is simple in design; one does not have to be mechanically inclined to construct it properly. All the research work has been done and the proper assembly carefully worked out for the builder by ten of the leading engineers of the country, who collaborated in the creation of an efficient five-tube receiver of unusual sensitivity, selectivity and volume.

The theory of this receiver is comparatively simple. It consists in the addition of a neutralized stage of tuned radio frequency amplification to a regenerative detector. Beyond the detector is an audio frequency amplifier such that all tones between 100 and 3,000 cycles are amplified alike, and those above 3,000 cycles are given a slight "boost" to compensate for the characteristics of the average horn.

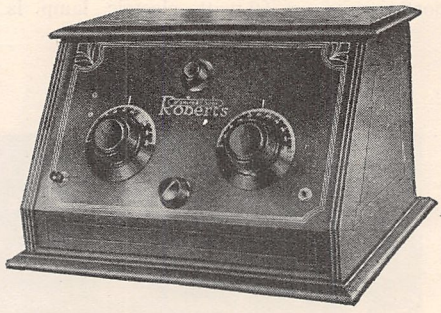
Tuning has been reduced to the simplicity of just two major controls. A sensitivity and a volume control are provided, in addition to the two major controls, to make the receiver so flexible in tuning as to meet every possible condition. All tubes but the radio frequency tube are controlled by separate amperites, which automatically adjust the tubes to their correct operating voltages. The radio frequency stage is controlled by a 25-ohm rheostat which serves as an efficient volume control.

LAYING OUT THE PARTS

It will be well for the builder to observe closely the system employed here in assembling and wiring this receiver. Usually it is the custom first to assemble all the units in their places, and then do all the wiring. Here the assembly is done jointly, with partial wiring. This tends towards ease of building, because the hand is not hindered by the presence of parts not yet necessary to the completion of the receiver. This also insures against mistakes on the part of the constructor.

It must be kept in mind that the tubes in this receiver are not laid out as in the conventional set. For simplicity in wiring, the first audio frequency tube is made the first, the radio frequency the second, the detector next, and the two audio tubes hooked in parallel are the fourth and fifth tubes.

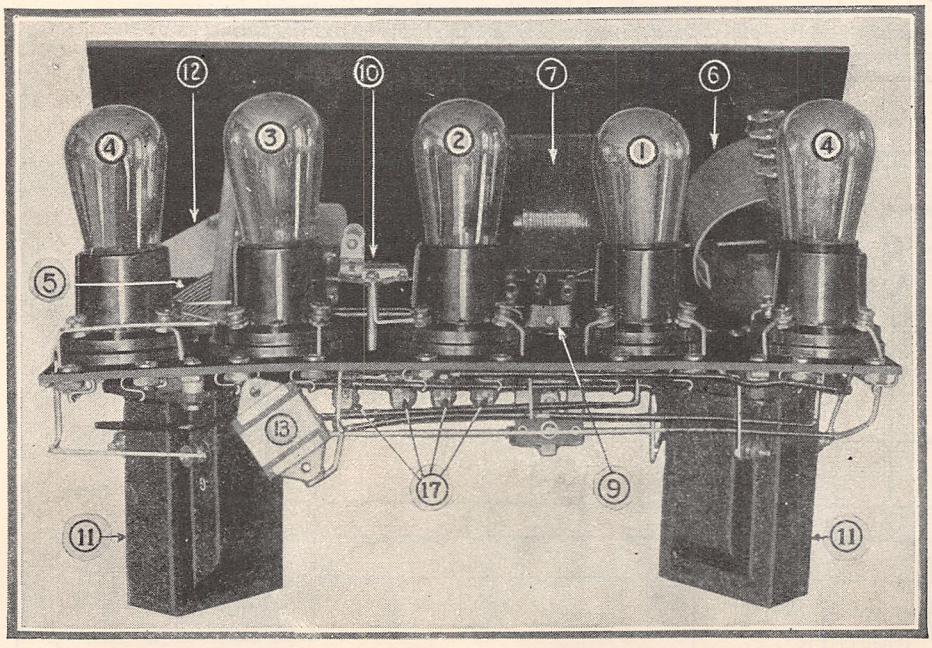
The antenna coupling coil consists of 50 turns of No. 24 D.S.C. wire wound on a three-inch form for the secondary and 15 turns of No. 26 D.S.C. wire on a 2¾-inch form for the primary. For the R.F. transformer; the primary has 25 turns on 2¾-inch diameter; the secondary 50 turns on 2-inch diameter, and the tickler coil has 30 turns on 1½-inch diameter. The primary and tickler coils are wound with No. 26, and the secondary with No. 24 D.S.C. wire. The illustration at the top of the next page depicts this last-described coil.



The panel view of the receiver that employs the Roberts circuit.
Photos courtesy of Hammarlund-Roberts.

BATTERIES AND TUBES

For the operation of the receiver two "C" batteries of 4.5 volts each are required, two or three 45-volt "B" batteries and a 6-volt storage battery for the five UV-201A tubes; or dry cells if UV-199 tubes are used. If tubes other than storage battery tubes are used, both "C" and "B" battery values should be changed to correspond with the directions supplied with the tubes.



The numbers in this illustration correspond with those at the bottom of the next page. By the use of a sub-panel a great amount of apparatus can be placed behind a relatively small front panel and yet there is no unnecessary crowding.

IT is against the policy of RADIO NEWS to publish the names of manufacturers or of makes of instruments in connection with the apparatus described in these pages, but this information will be gladly given privately. If you are interested in any special instruments described here, address a letter to the I WANT TO KNOW DEPARTMENT, enclosing stamped return envelope. The names and addresses of the manufacturers will be given free of charge. —EDITOR.

If it is desired to use the new 112 or 120 type of tube in the last audio stage, only one tube need be used instead of two. The amperite cartridges, though, will have to be changed for cartridges designed for the type of tube used.

Regulation of the "C" battery voltages is essential to correct operation of the radio and audio frequency stages of amplification; and it may be well to try different values of such voltages. The builder will readily observe the point at which most satisfactory operation is obtained.

The use of "C" batteries also reduces greatly the drain on "B" battery current, compared with that when no "C" batteries are used. This is quite important as it directly affects the length of life of the "B" batteries.

OPERATION

Assuming that the antenna, ground and loud speaker are connected to the set, turn the volume control on full and advance the sensitivity dial to its maximum position. Both knobs should be turned to the right to increase, and to the left to decrease. Now, on simultaneously rotating the two tuning dials at approximately the same settings, a squeal should be heard in the loud speaker, provided any stations are "on the air." Adjust the dials for maximum squeal and then reduce the setting of the sensitivity dial. This will eliminate the squeal and result in reception of music, or whatever is being broadcast at the time.

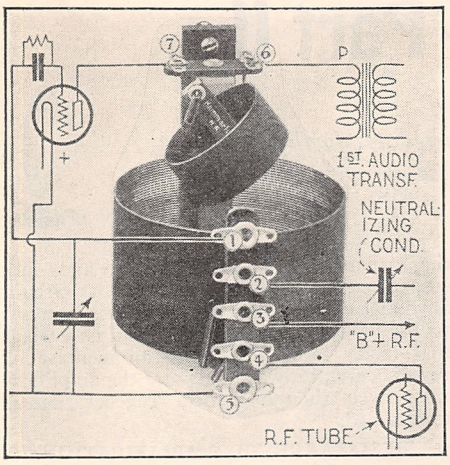
Perhaps on local stations the advancement of the volume control to its limit will produce distorted reception, because of tubes overloading. If this is the case, it is only necessary to reduce the setting of the volume control, or else reduce the amount of "B" battery voltage applied to the last audio amplifier tubes.

Regeneration should be obtained smoothly by advancing the sensitivity control; that is, the tube should go in and out of oscillation quite evenly and slowly. If this is not the case reduce the detector B voltage applied to the B + 45 jack.

The two major tuning dials should read very nearly or sometimes exactly alike, and it is possible to calibrate them so that at a glance it will be possible to know where to turn to find unlogged stations, if their frequency or wave-length be known.

To calibrate the dials it is only necessary to note the position of the dials when four or five, or as many as possible, stations have been successfully tuned in. By plotting the readings on cross-section paper a curve is obtained, which will show at a glance the setting of the dial for any particular frequency or wave-length at which a station may be broadcasting.

The volume control is a filament rheostat in the radio frequency amplifier tube. To prolong the life of the tube this should never



The above illustration shows the method of mounting the tickler coil and the various connections. The numbers indicate connections to parts shown in the diagram below.

be turned up any higher than necessary. It is impossible to harm the filament of this tube by turning the tube to full brilliancy, because of a safety fixed resistance of 4 ohms' resistance, which is placed in series with the rheostat.

The antenna taps on the first coil are for adjusting the receiver to the particular antenna used with the receiver. When the correct tap is found, the tuning of the two condensers will be practically alike; and to tune in one station after the other it is only necessary to rotate both condensers at the same time. It will not be necessary to have the detector oscillate to pick up stations, if the receiver is operated within two hundred miles of any moderately-powerful station.

Using the greater part of the antenna coil increases the signal strength to some extent but broadens the tuning, with a long antenna. The other taps increase the selectivity on the high frequency (low wavelengths); and on the low frequency (high wave-length) stations it will also lower the volume to some extent. If it is so desired, connection to these taps may be by means of a small clip, allowing any tap to be selected at will, according to the type of reception desired.

The quality of the tone of the receiver depends greatly upon the intelligent use of "B" and "C" batteries. Tubes also play an important part. It should be a matter of practice to change around the tubes in their sockets, to obtain maximum efficiency from each of the tubes by operating it at the place in the circuit at which it proves to be most efficient.

Experiments should be made with grid leaks of different values in order to attain maximum efficiency and sensitivity. All grid leaks and grid condensers vary a trifle from their rated values, but it will be found that some particular value of grid leak will give perfect results, depending upon the tube used, the value of the grid condenser, etc., etc.

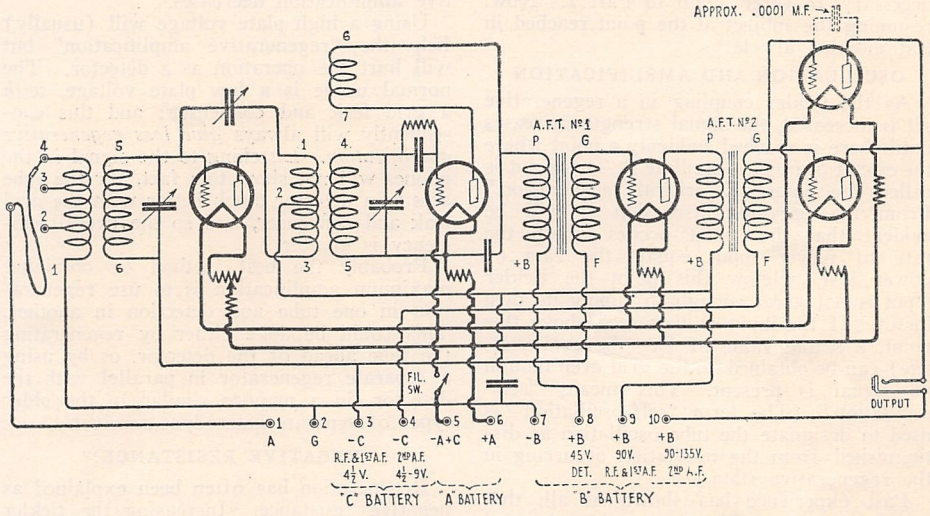
NEUTRALIZING THE RECEIVER

After the receiver has been entirely wired, and the constructor is satisfied that no trouble exists it is time to proceed with the neutralization of the set. If the set is not properly neutralized, the squeals which are heard in tuning are radiated from the antenna, and cause very objectionable noises in all neighboring receivers which at the time happen to be operating on the same wavelength.

Tune in some moderately strong station, and, listening in with head phones or loud speaker, turn out the radio frequency amplifier tube by turning the volume control to the extreme left. Adjust the midget condenser setting until signals either disappear entirely or are at a decided minimum. It will be necessary to retune slightly after this adjustment; and then the tube should again be turned out and the midget condenser readjusted slightly to a more exact position. It will be found that there is a distinct minimum of sound when the neutralizing condenser has been correctly set.

After neutralization has been accomplished you may feel perfectly confident that you can in no way annoy your neighbors by radiating distracting squeals.

If the amplifier cannot be neutralized, it indicates unwanted coupling between the grid and plate of the first tube. Wires running near one of the coils should not be run near the other coil or coil wiring; since coupling may result which will make it impossible to neutralize the receiver.

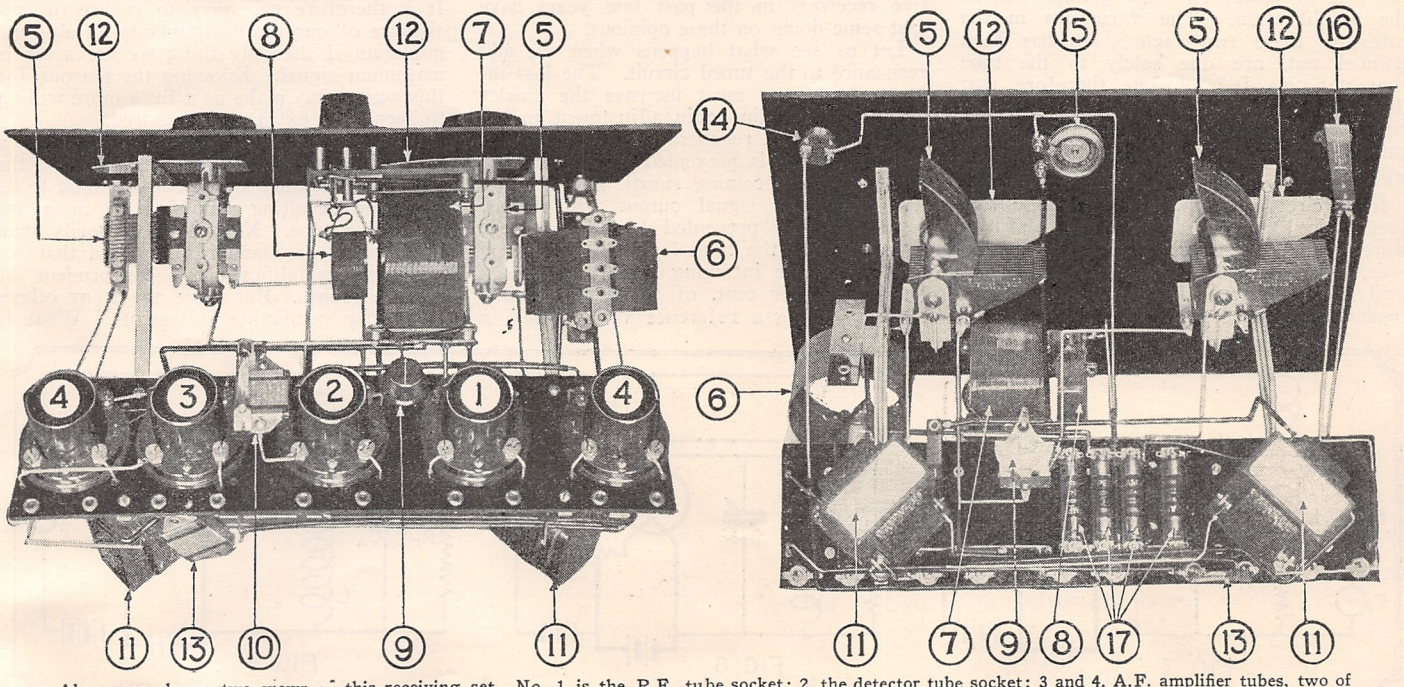


The wiring diagram, showing the connections of the five tubes, illustrates the method of combining R.F. amplification with regeneration.

LIST OF PARTS

2 low-ratio A.F. transformers,
2 .0005-μf. S.L.F. condensers,

(*Continued on page* 1593)



Above are shown two views of this receiving set. No. 1 is the R.F. tube socket; 2, the detector tube socket; 3 and 4, A.F. amplifier tubes, two of which are in parallel; 5, variable condensers .0005-mf.; 6, antenna coupler; 7, R.F. transformer; 8, tickler coil; 9, neutralizing condenser; 10, grid leak and condenser; 11, A.F. transformers; 12, shielding; 13, by-pass condenser; 14, filament switch; 15, rheostat; 16, jack; 17, automatic filament adjusters. *Photos courtesy of Hammarlund-Roberts.*

What Is Regeneration—Part II

By KENNETH W. JARVIS*

In this, the conclusion of his interesting and instructive article, Mr. Jarvis sets forth just how efficient the regenerative circuit is. Every radio enthusiast should know the principle underlying this phase of radio.

PART I of this article, which appeared on page 1440, *et seq.*, of RADIO NEWS for April, was devoted to the proposition that regeneration is neither more nor less than oscillation of the electron tube, controlled by the incoming signal. The method of this control must be thoroughly understood, before it is possible to reach the reason for the various phenomena to be explained in the second part of this article. For this reason, the reader is cautioned not to proceed further until the previous course of the discussion is fully grasped by him; and, if necessary, to refer again to Part I. Now, resuming the subject at the point reached in last month's article:

OSCILLATION AND AMPLIFICATION

As the tickler coupling in a regenerative set is increased, the signal strength increases until there is reached suddenly a point where the circuit begins to "oscillate." This point is called the point of "critical regeneration." From the previous discussion it will be evident that this point occurs where the rate of power input equals the rate of power lost. Below this point the tickler input is not great enough to supply its own losses. If the input is increased above this point, a stable value of E_g (the grid voltage) can be obtained on the grid even though no signal is present. This means "self-oscillation." (The term "self-oscillation" is used to designate the tube oscillation as distinguished from the oscillation occurring in the regenerative state.)

Past experience has shown us all, that satisfactory reception cannot be obtained above the point of critical regeneration. Of course we want the maximum amplification possible. A stronger signal will result, the closer the tickler is adjusted to this point of critical regeneration. A close analysis of the action shows that the more nearly the rate of power feed-back corresponds to the rate of power loss, the greater will be the amplification. The variations in the rates of these two factors, as has been pointed out, are due solely to the tube characteristics. It is obvious, therefore, that the choice of the tube, and *not the type of circuit*, determines the regenerative amplification.

EFFECT OF GRID LEAK AND CONDENSER

In the circuits so far discussed, it may have been noticed that no grid condenser and leak were used. It is now common practice, however, to regenerate the detector, using a grid leak and condenser. The action of regeneration is essentially the same, the variations being due to the change in tube-characteristic curves when using a grid leak and condenser. Variations in the value of the grid leak change the tickler input and the input impedance of the tube. For some tubes a high leak resistance is best; for others a low leak gives the strongest signals. In order to operate a tube detector at its best rectifying efficiency, a low plate voltage (15 to 30 volts) is necessary. With this low plate voltage, when using a grid leak and condenser, the power input from the tickler does not increase as fast as the grid circuit loss increases, and so the regenerative amplification decreases.

Using a high plate voltage will (usually) help the "regenerative amplification" but will hurt the operation as a detector. The normal usage is a low plate voltage, *with* a grid leak and condenser; and this consequently will always *give less regenerative amplification.* Listening to the signal in the phones will not show this fact, for the tube acts as a detector much better with the grid leak and condenser, and so the overall efficiency is greater.

Probably the best method of obtaining maximum amplification is to use regeneration in one tube and detection in another. This could be done either by regenerating the tube ahead of the detector, or by using a separate regenerator in parallel with the detector, in a manner similar to the older types of separate heterodyne receivers.

"NEGATIVE RESISTANCE?"

Regeneration has often been explained as negative resistance. Increasing the tickler coupling was thought to be equivalent to cancelling some of the resistance of the circuit. Thus if the tube and associated circuits could be made to oscillate (i.e., negative resistance made equal to positive resistance) it was assumed that the initial value of resistance made no difference. The results obtained with "low-loss" regenerative receivers in the past few years have cast some doubt on these opinions.

Let us see what happens when we add resistance to the tuned circuit. The loss increases and we must increase the tickler coupling to obtain again adjustment to the point of critical regeneration. If a certain amount of loss is prevented from occurring in R_p by the incoming signal, it is obvious that a greater signal output will be the result—if this "prevented loss" is a large percentage of the total loss.

Thus, if the incoming signal prevents a loss of 60 per cent. of the total original loss (assuming a reference voltage E_g) in the case of a "low-loss" circuit, and only 40 per cent. in the case of a high-loss circuit, anyone can see that the "low-loss" circuit will give the largest signal. It is evident that under these conditions, an increase of resistance will always *decrease* the amplification, even though critical regeneration is maintained.

RESISTANCE VS. AMPLIFICATION

Table 1 gives the relation between added series resistance and the resulting grid voltage. *Critical regeneration was maintained at all times.* Notice how fast the amplification increases as the resistance decreases. If the resistance of the tuned circuit could be made zero, an infinite amplification would be obtained. This change in amplification as the loss changes is due also to the characteristic curves of the tube used.

TABLE 1

Added series Resistance Ohms	Amplification factor
0	74.0
10	55.0
20	43.0
30	35.0
40	29.0
50	25.5
75	19.0
100	16.0
150	12.5

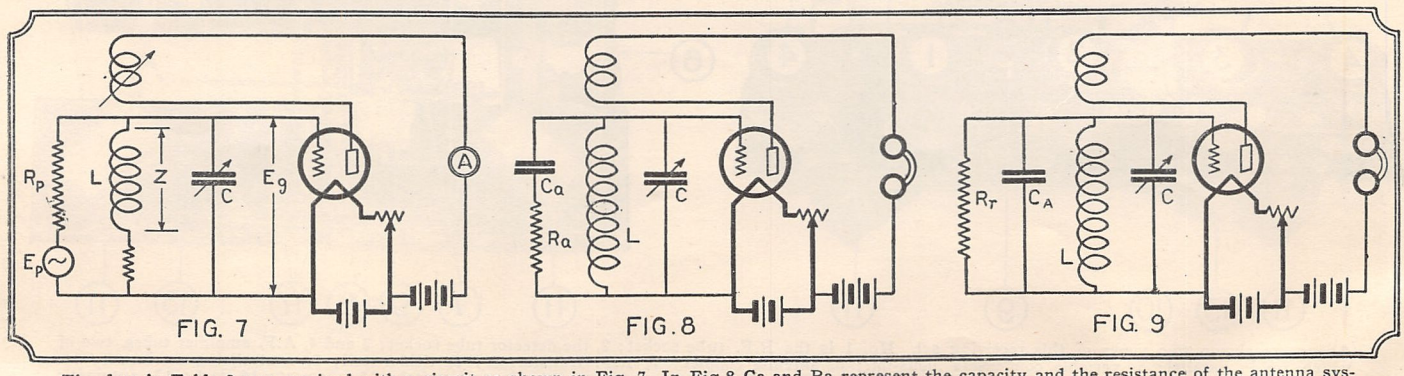
TABLE 2

Applied signal E_g. Volts	Amplification factor
.00125	425
.0025	260
.005	155
.01	90
.02	55
.03	45
.04	35

In a high-loss circuit the effect of the tube variations is magnified; in a low-loss circuit they lose some of their importance.

With some kinds of tubes, the variations are reversed. That is, *an increase in resistance would give a greater voltage on the grid.* This is an extremely unusual case, however, but has been done in the laboratory. It is therefore necessary to reduce the resistance of our tuned circuits to an absolute minimum if the only thing we are after is maximum signal. Knowing the reasons for this action may make us a little more willing to spend the extra time required.

In radio circles it has always been a much debated question as to whether the strength of applied signal had anything to do with the resulting amplification in a regenerating tube. No less an authority than the Bureau of Standards has said that regenerative amplification is independent of signal strength. But there are many others who offer conflicting statements. What is



The data in Table 2 was obtained with a circuit as shown in Fig. 7. In Fig 8 Ca and Ra represent the capacity and the resistance of the antenna system. In Fig. 9 this antenna resistance is placed in shunt with the capacity, for the reasons found on page 1598.

* *Engineering Department, Crosley Radio Corp.*

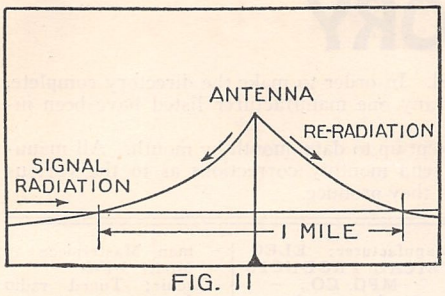


FIG. 11

A side view of the hypothetical fields surrounding a regenerated antenna.

the truth of the matter? Let us take the conditions as shown in Fig. 7 with critical regeneration and apply various voltages E_p to the circuit. These applied voltages serve only to prevent a loss occurring in R_p, and enable the tube to build up a voltage on its grid.

SIGNAL STRENGTH VS. AMPLIFICATION

Table 2 was obtained in such a manner, using an extremely sensitive tube voltmeter. It may be seen that *as the input signal decreases, the amplification increases!* (This does not mean that the output is larger.) This is an effect which we would not honestly dare to ask for. This also gives one more strong point in favor of our old regenerative sets. Regardless of the type of set, be it neutrodyne or super-heterodyne not using regeneration, if the strength of the incoming signal be continuously reduced, *a point will eventually be reached where a single regenerating tube will give more signal than any other set.*

This seems almost unbelievable in this day when the average set purchaser believes that the more tubes he has the finer his set. In justice to the neutrodyne and super-heterodyne, however, we must admit that this weak signal strength usually lies below the noise level of atmospheric interference; and so we cannot always take advantage of this great amplification. This very effect also has a detrimental effect in amplifying weak interference, far out of proportion to the signal, and so often tends to make a regenerating tube sound as though it were hissing.

"BEAT" RECEPTION PHENOMENA

One of the most peculiar phenomena of regeneration can barely be touched upon here. This refers to the phenomena of "Locking In" and "Zero Beat" reception. Every regenerative set user is aware of the difficulty in making his circuit oscillate, when receiving a strong local signal. Or if it is already oscillating, and the receiver be retuned to the local station, a beat note will be heard as the receiver's oscillating frequency approaches the carrier-wave frequency of the station. This heterodyne beat commences at the limit of audibility and decreases as the receiver comes more nearly into resonance. The production of such audio beats has been described many times, and nothing will be added here except to note that the frequency is the difference between the carrier frequency and the frequency of the receiver.

The beat frequency may decrease to a value as low as 500 cycles and then suddenly cease, reappearing with a value of about 500 cycles after the resonance point has been passed. If the strength of the oscillations in the receiver is decreased, the beat frequency can be carried much lower. The only explanation possible is that the receiver is oscillating at the same frequency as the incoming signal, in spite of the fact that it is not tuned to that frequency! The complete action is very difficult to explain and cannot be given in detail here. See the citation, page 1489, April Radio News.

We have seen how the incoming signal controls the voltage and power relations in a regenerating tube. In a somewhat similar manner the incoming signal can also control the phase relation. If the incoming signal is strong and the local oscillation is weak, the receiver "locks in" at a very high frequency. There is always a tendency for the local receiver to follow the frequency of the incoming signal, even when tuned to another frequency. If the amount of detuning is not too great, the incoming signal wins. Even when the regenerative receiver is weakly oscillating and receiving a very weak distant station, the small received signal is still strong enough to force the receiver to follow the modulation frequency, rather than the frequency to which it is tuned.

SHARPNESS OF TUNING

Next to the increased signal strength, probably the most important function of a regenerative receiver is to sharpen the tuning. This sharpness of tuning is due to the high amplification of the signal to which the receiver is tuned, with only a low amplification of non-resonant frequencies. We have seen that the high amplification of a regenerative set is due to the tickler feedback. It has also been stated that this feedback is due to the tickler impedance, which in turn is due to its coupling to the grid circuit.

Thus we see that the tickler feed-back will be at only the frequency to which the grid circuit is tuned. If any other frequency is impressed on the grid circuit, the tickler will have very little impedance at that frequency, and consequently will not feed back any power to the grid circuit. Therefore very little amplification results at the non-resonant frequencies.

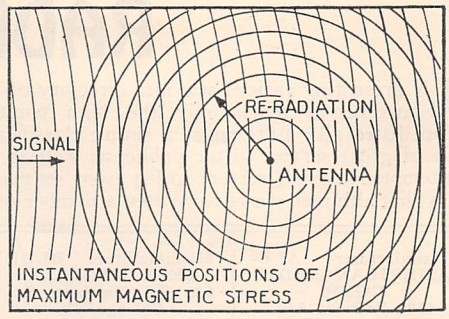


FIG. 10

A vertical view of the wave-form, entering and leaving an antenna.

One curious effect in connection with sharpness of tuning occurs. We have seen that the amplification varies with incoming signal strength. Due to many of the same reasons, the sharpness of tuning increases as the incoming signal strength decreases. This effect is noticeable when receiving weak signals with critical regeneration, when the speech and music becomes "drummy." This is due to the loss of the higher notes, which are cut off, due to the extremely sharp resonance curve.

LOSS OF ENERGY THROUGH ANTENNAE

All of the previous portion of this article has been devoted to regeneration with a stage of radio frequency amplification ahead. The application of regenerative phenomena explanations to an antenna is a great deal harder, because even today we do not know the exact way in which electro-magnetic radiations are propagated or received. We have seen that the resistance R_p of a vacuum tube plate circuit causes a damping, or a power loss, when connected across a tuned circuit. When a tuned circuit is connected to an antenna, there is a certain power loss due to what has been termed antenna resistance.

A large portion of this antenna resistance is known as "radiation resistance," and represents the amount of energy lost by the tuned circuit, which has been radiated into space. The equivalent circuit for an antenna under these considerations is shown in Fig. 8, where C_a is the capacity of the antenna to ground and R_a is the equivalent antenna resistance. The value of this equivalent re-

(*Continued on page* 1598)

LIST OF BROADCAST STATIONS IN THE UNITED STATES

(*Continued from page* 1538)

Radio Call Letter	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WLTS,	Chicago, Ill.	258	100
WLW,	Harrison, Ohio	422.3	500-5000
WLWL,	New York, N. Y.	288.3	1500
WMAC,	Cazenovia, N. Y.	275	100
WMAF,	Dartmouth, Mass.	440.9	1000
WMAK,	Lockport, N. Y.	266	500
WMAL,	Washington, D. C.	212.6	15
WMAN,	Columbus, Ohio	278	50
WMAQ,	Chicago, Ill.	447 5	1000
WMAY,	St. Louis, Mo.	248	100
WMAZ,	Macon, Ga.	261	500
WMBB,	Chicago, Ill.	250	500
WMBC,	Detroit, Mich.	256.4	100
WMBF,	Miami Beach, Fla.	384.4	500
WMC,	Memphis, Tenn.	499.7	500
WMCA,	Hoboken, N. J.	340.7	500
WNAB,	Boston, Mass.	250	100
WNAC,	Boston, Mass.	280.2	500
WNAD,	Norman, Okla.	254	500
WNAL,	Omaha, Nebr.	258	50
WNAT,	Philadelphia, Pa.	250	100
WNAX,	Yankton, S. Dak.	244	100
WNBH,	New Bedford, Mass.	248	250
WNJ,	Newark, N. J.	252	150
WNOX,	Knoxville, Tenn.	268	100
WNYC,	New York, N. Y.	526	1000
WOAI,	San Antonio, Tex.	394.5	2000
WOAN,	Lawrenceburg, Tenn.	282.8	500
WOAW,	Omaha, Nebr.	526	1000
WOAX,	Trenton, N. J.	240	500
WOC,	Davenport, Iowa	483.6	5000
WOCL,	Jamestown, N. Y.	275	15
WODA,	Paterson, N. J.	224	250
WOI,	Ames, Iowa	270	750
WOK,	Homewood, Ill.	217.3	5000
WOKO,	New York, N. Y.	233	50
WOO,	Philadelphia, Pa.	508.2	500
WOOD,	Grand Rapids, Mich.	242	500
WOQ,	Kansas City, Mo.	278	1000
WOR,	Newark, N. J.	405.2	500
WORD,	Batavia, Ill.	275	5000
WOS,	Jefferson City, Mo.	440.9	500
WOWL,	New Orleans, La.	270	10
WOWO,	Fort Wayne, Ind.	227	500
WPAK,	Agricultural Col., N. Dak	275	50
WPCC,	Chicago, Ill.	258	500
WPG,	Atlantic City, N. J.	299.8	500
WPRC,	Harrisburg, Pa.	215.7	100
WPSC,	State College, Penna.	261	500
WQAA,	Parkesburg, Pa.	220	500
WQAC,	Amarillo, Tex.	234.2	100
WQAE,	Springfield, Vt.	246	50
WQAM,	Miami, Fla.	263	100
WQAN,	Scranton, Pa.	250	100
WQAO,	New York, N. Y.	360	100
WQJ,	Chicago, Ill.	447.5	500
WRAF,	Laporte, Ind.	224	100
WRAM,	Galesburg, Ill.	244	100
WRAV,	Yellow Springs, Ohio	263	100
WRAW,	Reading, Pa.	238	10
WRAX,	Gloucester City, N. J.	268	500
WRBC,	Valparaiso, Ind.	278	50
WRC,	Washington, D. C.	468.5	1000
WRCO,	Raleigh, N. C.	252	100
WREC,	Coldwater, Miss.	254	10
WREO,	Lansing, Mich.	285.5	500
WRHF,	Washington, D. C.	256	50
WRHM,	Minneapolis, Minn.	252	50
WRK,	Hamilton, Ohio	270	100
WRM,	Urbana, Ill.	273	500
WRMU,	Richmond Hill, N. Y.	236	100
WRNY,	New York, N. Y.	258.5	500
WRR,	Dallas, Tex.	246	500
WRST,	Bay Shore, N. Y.	215.7	250
WRVA,	Richmond, Va.	256	1000
WRW,	Tarrytown, N. Y.	273	500
WSAI,	Mason, Ohio	325.9	5000
WSAJ,	Grove City, Pa.	229	250
WSAN,	Allentown, Pa.	229	100
WSAR,	Fall River, Mass.	254	100
WSAX,	Chicago, Ill.	268	100
WSAZ,	Pomeroy, Ohio	244	50
WSB,	Atlanta, Ga.	428.3	1000
WSBC,	Chicago, Ill.	209.7	1000
WSBF,	St. Louis, Mo.	273	250
WSBT,	South Bend, Ind.	275	250
WSDA,	New York, N. Y.	263	250
WSKC,	Bay City, Mich.	261	100
WSM,	Nashville, Tenn.	282.8	1000
WSMB,	New Orleans, La.	319	500
WSMH,	Owosso, Mich.	240	20
WSMK,	Dayton, Ohio	275	500
WSOE,	Milwaukee, Wis.	246	500
WSRO,	Hamilton, Ohio	252	100
WSSH,	Boston, Mass.	261	100
WSUI,	Iowa City, Iowa	483.6	500
WSVS,	Buffalo, N. Y.	218.8	50
WTAB,	Fall River, Mass.	266	100
WTAD,	Carthage, Ill.	236	50
WTAG,	Worcester, Mass.	268	500
WTAL,	Toledo, Ohio	252	10
WTAM,	Cleveland, Ohio	389.4	3500
WTAP,	Cambridge, Ill.	242	50
WTAQ,	Osseo, Wis.	254	100
WTAR,	Norfolk, Va.	261	100
WTAW,	College Station, Texas	270	500
WTAX,	Streator, Ill.	231	50
WTAZ,	Lambertville, N. J.	261	15
WTIC,	Hartford, Conn.	475.9	500
WWAD,	Philadelphia, Pa.	250	250
WWAE,	Plainfield, Ill.	242	500
WWAO,	Houghton, Mich.	263	250
WWGL,	Richmond Hill, N. Y.	212.6	500
WWI,	Dearborn, Mich.	266	500
WWJ,	Detroit, Mich.	352.7	1000
WWL,	New Orleans, La.	275	100

RADIO SET DIRECTORY

IN presenting various sets in a directory of this kind, it is naturally possible to touch only the high points. We have therefore listed all outfits under a simple classification that will, we hope, be of great service to the public, as well as to the trade. We have attempted in this directory to list every set manufactured in this country, but although we have written a number of letters to all manufacturers, not all have replied. In order to make the directory complete, all sets manufactured by any one manufacturer listed have been included.

The Directory will be kept up to date, month by month. All manufacturers are invited to send monthly corrections as to the various features of the sets which they produce.

Manufacturer: ALL-AMERICAN RADIO CORP., 4201 Belmont Ave.. Chicago, Ill.
Trade Name: All-American Model "R"
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor
Loud Speaker: separate
Controls: Two
List Price: $90

Manufacturer: ATWATER KENT MFG. CO., 4700 Wissahickon Ave., Philadelphia, Pa.
Trade Name: Atwater Kent Model 10
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $80

* * *

Trade Name: Atwater Kent Model 12
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $100

* * *

Trade Name: Atwater Kent Model 19
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Two
List Price: $60

* * *

Trade Name: Atwater Kent Model 20
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $80

* * *

Trade Name: Atwater Kent Model 20 Compact
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $80

* * *

Trade Name: Atwater Kent Model 21 Compact
Circuit: Tuned radio frequency
Batteries: Dry cell
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $80

* * *

Trade Name: Atwater Kent Model 24 De Luxe
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $100

Manufacturer: BLUE SEAL MFG. CO., 538 So. Dearborn St., Chicago, Ill.
Trade Name: Blue Seal tuned radio frequency
Circuit: Tuned radio frequency
Batteries: Storage
Antenna: Outdoor or indoor
Loud Speaker: Separate
Controls: Three
List Price: $135

Manufacturer: CHELSEA RADIO CO., 150 5th St., Chelsea, Mass.
Trade Name: Chelsea No. 140
Circuit: Armstrong Regenerative 3-circuit
Batteries: Either
Antenna: Outdoor
Loud Speaker: Separate
Controls: 1
List Price: $26

* * *

Trade Name: Chelsea Super-5
Circuit: 2 stages tuned radio frequency detector, 2 audio amplification
Batteries: Storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three
List Price: $50

* * *

Trade Name: Chelsea Super-6 tuned radio frequency
Circuit: 2 tuned radio frequency, detector 3 special audio amplifier
Batteries: Storage
Antenna: Either
Loud Speaker: Separate
Controls: Three
List Price: $60

Manufacturer: THE CROSLEY RADIO CORP. Cincinnati, Ohio
Trade Name: Crosley Pup
Circuit: Regenerative
Batteries: Dry cell
Antenna: Outdoor
Controls: Two
List Price: $9.75

* * *

Trade Name: Model IV-29
Circuit: Tuned Radio Frequency with Regenerative Detector
Batteries: Dry Cell or Storage
Antenna: Outside
Loud Speaker: Separate
Controls: Two
List Price: $29

* * *

Trade Name: Model V-38
Circuit: Tuned Radio Frequency with Regeneration
Batteries: Dry Cell or Storage
Antenna: Outside
Loud Speaker: Separate
Controls: Three
List Price: $38

* * *

Trade Name: Model R F L-60
Circuit: Tuned Radio Frequency
Batteries: Storage
Antenna: Outside
Loud Speaker: Separate
Controls: Three
List Price: $60

* * *

Trade Name: R F L-75
Circuit: Tuned Radio Frequency
Batteries: Storage
Antenna: Outside
Loud Speaker: Separate
Controls: Three
List Price: $75

Manufacturer: DAYTON FAN & MOTOR CO. Monument and Meigs Sts. Dayton, Ohio
Trade Name: O. E. M. 12.
Circuit: Tuned radio frequency
Batteries: Dry cell or storage.
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three
List Price: $75.00

* * *

Trade Name: O. E. M. 7
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three
List Price: $98.00

* * *

Trade Name: Dayola
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three
List Price: $110.00

* * *

Trade Name: Day-Fan
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: One
List Price: $115.00

* * *

Trade Name: Dayroyal
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: One
List Price: $250.00

* * *

Trade Name: Dayphone
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: One
List Price: $105.00

* * *

Trade Name: Daycraft
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: One
List Price: $145.00

* * *

Trade Name: Daygrand
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: One
List Price: $195.00

* * *

Trade Name: Daytonia
Circuit: Tuned radio frequency
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Built-in
Controls: One
List Price: $300.00

Notice to Readers

Detailed information respecting the following sets, or any other receiving sets, may be had on inquiry by addressing a letter to the Editor of the Set Directory, RADIO NEWS.

Manufacturer: DE WITT-LA FRANCE CO. 54 Washburn Ave., Cambridge, Mass.
Trade Name: Superadio Reactodyne R. F.
Circuit: Radio frequency
Batteries: Storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Two
List Price: $56

Manufacturer: THE W. B. DUCK CO., 711 Adams St., Toledo, Ohio
Trade Name: Duck Type A-884 De Luxe Balanced
Circuit: Tuned Radio Frequency
Batteries: Both
Antenna: None
Loud Speaker: Separate
Controls: Three
List Price: $95

* * *

Trade Name: Type A 885 Six Tubes
Circuit: Tuned radio frequency
Batteries: Both
Antenna: None
Loud Speaker: None
Controls: Three
List Price: $150

* * *

Trade Name: Type A 886 Six Tubes
Circuit: Tuned radio frequency
Batteries: Both
Antenna: None
Loud Speaker: None
Controls: Three
List Price: $200

Manufacturer: ELECTRICAL PRODUCTS MFG. CO., 69 Sprague St., Providence, R. I.
Trade Name: Dymac Selecto-5
Circuit: Dymac Balanced radio frequency
Batteries: Storage
Antenna: Outdoor
Loud Speaker: Separate
Controls: Three Dials
List Price: $75

Manufacturer: ELECTRICAL RESEARCH & MFG. CO., Waterloo, Ia.
Trade Name: Superiorflex Model S-3
Circuit: Superiorflex—double reflex
Batteries: Dry cell or storage
Antenna: Outdoor
Loud Speaker: Separate
Control: One
List Price: $85.00

Manufacturer: ELECTRICAL RESEARCH LABORATORIES, 2500 Cottage Grove Ave. Chicago, Ill.
Trade Name: Erla Circloid Five De Luxe cabinet
Circuit: Tuned radio frequency, licensed under U. S. Navy patent
Batteries: Storage
Antenna: Both
Loud Speaker: Separate
Controls: Three
List Price: $77.50

* * *

Trade Name: Erla Circloid Five De Luxe cabinet
Circuit: Tuned radio frequency, licensed under U. S. Navy patent
Batteries: Storage
Antenna: Both
Loud Speaker: Separate
Controls: Three
List Price: $69.50

* * *

Trade Name: Erla Circloid Five De Luxe cabinet
Circuit: Tuned radio frequency, licensed under U. S. Navy patent
Batteries: Storage
Antenna: Both
Loud Speaker: Built-in
Controls: Three
List Price: $142.50

* * *

Trade Name: Erla Circloid Five De Luxe cabinet
Circuit: Tuned radio frequency, licensed under U. S. Navy patent
Batteries: Storage
Antenna: Both
Loud Speaker: Built-in
Controls: Three
List Price: $113.50

Manufacturer: CHARLES FRESHMAN, INC. 240-248 W. 40th St., New York City and 327 So. LaSalle St. Chicago, Ill.
Trade Name: Freshman Masterpiece Model 5-F-2
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Separate
Controls: Three
List Price: $39.50

* * *

Trade Name: Freshman Masterpiece Model 5-F-5
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price: $60

* * *

Trade Name: Freshman Masterpiece Model 5-F-4
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Separate
Controls: Three
List Price: $49.50

* * *

Trade Name: Freshman Masterpiece Concert Model
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price: $75

* * *

Trade Name: Freshman Masterpiece set of Franklin Console
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price $75

* * *

Trade Name: Freshman Masterpiece Model 5-F-8
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price: $89.50

* * *

Trade Name: Freshman Masterpiece Model 5-F-6 with table
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price: $82.50

* * *

Trade Name: Freshman Masterpiece Franklin Console
Circuit: Tuned radio frequency
Batteries: Either
Antenna: Outdoor or indoor (no loop)
Loud Speaker: Built-in
Controls: Three
List Price: $115

To be continued in the June RADIO NEWS

Correspondence from Readers

In this department the readers air their views on many important questions of the day. Comment is invited and an attempt is made to give equal weight to both sides of a controversy regardless of the magazine's policy.

REFLEX RECEIVER

Editor RADIO NEWS:

I wish to thank Mr. Arthur Reed for the set he described in the January, 1926, issue of RADIO NEWS. It may not be anything new in theory, but it was new to me as a beginner. I built the set and am more than pleased with the results I have had with it. Among the stations I have heard are KDKA, WMBF, and KFI. I am getting good loud speaker volume but would like to get just a little more. The nearest station to this place is about one thousand miles and a very powerful set is needed for good results.

CLYDE WALCUTT,
Staff Sergt. Signal Corps,
Camp Gaillard, Canal Zone.

DX FROM SPAIN

Editor, RADIO NEWS:

I take pleasure in informing you that I have heard the station WGY very strongly and clearly, between four and five o'clock yesterday morning, in this city with the set described in RADIO NEWS for July, 1925, (Page 49) "A Non-Radiating R.F. Receiver;" and authorize you to make any use of this letter you wish.

Availing myself of the occasion to testify my regards.

MIGUEL SORRIBAS,
Diputacion 152, (5th),
Barcelona, Spain.

THE SINGLE-CONTROL REGENERATIVE INTERFLEX

Editor RADIO NEWS:

I've just completed the "Regenerative Interflex" described in RADIO NEWS for December, 1925. The trouble with this set is that you are too modest in your claims for it, for it is the most remarkable receiver on the market today. I did not expect the wonderful results obtained from it. I can make affidavit, with my wife's signature as a witness, to the effect that this receiver, with only the detector tube, brought in on loud speaker KFDM, Beaumont, Texas, 40 miles; KPRC, Houston, Texas, about 90 miles; KOIL, Council Bluffs, Iowa, 600 miles; WLIB, Chicago, 800 miles; KFKX, Hastings, Neb., 700 miles, and KDKA, 900 miles; and numerous other stations that I did not care to hear their call letters. Now these are actual facts; though it may sound unreasonable, it is true. The receiver separates three stations on two points on the dial, also, which shows it is as selective as one could desire. With the two stages audio we could not stay in a fairly large room, the volume was so great. This receiver has no fancy makings in it; as I made the coil, as per your directions, used 201A tubes throughout, All-American 3:1 transformers, Carborundum Crystal, and Bradleystat, using Amsco SLF Condenser. I found the volume better by putting .00025 fixed condenser across secondary of last audio stage. To say I'm pleased with the circuit would be putting it mildly. I've made a dozen receivers from the one-tubes to the excellent 8 super-heterodyne, and I think this the most remarkable receiver, tube for tube, on the market for the amateur to construct. I want to thank you personally, Mr. Gernsback, for the circuit, and also to say a good word of praise for your most excellent magazine, RADIO NEWS.

W. H. NICHOLS,
DeQuincy, La.

Editor RADIO NEWS:

It gives me pleasure to congratulate you on your Regenerative Interflex. My Radio Classes join me in this. We have constructed seven of these sets and each one with complete success. It ought to be a boon to the old folks who can not, or do not care to, twirl a lot of dials and knobs. The most remarkable factors noticed by us are:

1—DX.
2—Clearness of signals.
3—Quality on loud speakers.
4—Selectivity.

This, of course, agrees with your articles.

CARL LAURIER,
Director Department of Science,
Park Ridge High School, Park Ridge, N. J.

WHAT DO YOU THINK?

Editor, RADIO NEWS:

I have made some interesting observations about my radio, which, although not new, I have never seen printed. I am using a 4-tube resistance-amplifier and your cascade receiver. The amplifier has a choke to bypass the plate current around the phones. The last two tubes are UX-112. I discovered recently that while listening to a powerful station, I could entirely disconnect the phones and loud speaker and hear music and speech directly from the set.

I think that the sound is coming from the transformer used as a choke, but my local radio dealer said that it came from the tube. I would like your opinion, or that of the readers of this page, as to the explanation of this phenomenon.

RALPH BAILEY,
51 Morse Place,
Rutland, Vt.

TWO SETS ON THE SAME BATTERIES

Editor, RADIO NEWS:

I have tried the experiment of using the same "A" and "B" batteries for two radio sets at the same time, and would like to let you know the results.

One set consisted of five tubes; the usual two stages tuned R.F., detector and two of A.F.; while the other was a three-tube single-circuit regenerative circuit. Connecting up the 5-tube set as usual, I ran jumper wires from the 90+ binding post to the same connection on the 3-tube set. After doing likewise with all battery connections, I connected the outside antenna to the regenerative set and an inside antenna to the aerial post of the 5-tuber. Only one ground connection was used, this going to the 5-tube set. (If two ground connections are used, a small fixed condenser will have to be connected in the lead, or the batteries will be short-circuited.)

I was surprised at the results obtained. As it was a poor night for reception, WEAF could just be heard on the loud speaker, using five tubes. When the 3-tube set was switched on, to my surprise it came in with good volume on the speaker. All the other stations also came in with about twice as much volume as before. I found out that both sets had to be tuned to the same station before any increase in volume could be noticed.

I also tried using just the detector tube of the regenerative set, and found the volume about the same with increased clearness. Using all three tubes, the music was distorted and not clear. I used 199 tubes in the 3-tube and 201-A in the 5-tube set. The extra voltage on the 199 tubes was taken care of by connecting a potentiometer as a rheostat in the "A—" lead; two connections (middle and one side only) of the potentiometer were used. This plan seems a very good one to me when another tube is to be added to a 5-tube set.

Now, you "hams" and "B.C.L." guys, get a couple of sets together and try this experiment; and be sure to let me know how it works. I don't know whether it has been tried before, but I never have read of it anywhere, and I think it will be something new to fool with. Perhaps some wise amateur will link several transmitters together and work China (from Hong Kong). I would be very glad to hear from anyone trying this trick, either through RADIO NEWS correspondence columns, or direct.

PAUL AMTOWER,
129 Oak Street,
Cumberland, Md.

THE INTERFLEX FOUR

Editor, RADIO NEWS:

The Interflex Four has given me the surprise of my life. After experimenting with various transformers, I connected an Acme R-2. I also added about four turns on the secondary of the inductance coil, and the results are more than satisfactory.

Imagine, with an aerial (outside) of over 150 feet, I tune in all Chicago stations without any interference with one another! I intend to shorten the antenna to 75 feet.

But the most satisfaction I get in the Interflex is the wonderful clear reception. It surpasses anything I have ever heard.

I thank you for your kind assistance, and assure you that RADIO NEWS will always be my favorite radio magazine.

KARL F. ENGLEHARD,
1421 Rascher Ave.,
Chicago, Ill.

INTERFLEX RECORDS

Editor, RADIO NEWS:

I just want to outline my successful results with the Balanced Interflex. I built according to the description of same in December RADIO NEWS, and, believe me, it is the best and simplest outfit yet, and for purity of tone unexcelled. Extremely low tones and also extremely high tones perfect and without the least distortion. Selective beyond even my fondest hope, as I can get KDKA easily without any interference from our local WSAI, only fourteen miles distant. My youngest daughter, only 6 years of age, tunes with the skill of a professional, as do all the rest of my older children, and wife. I certainly am very proud and am showing and demonstrating to all my friends and acquaintances this wonderful Interflex, and when I say I certainly am an Interflex booster, I am putting it mildly.

L. H. WESSEL,
611 Clark Street,
Middletown, Ohio.

Editor, RADIO NEWS:

We have constructed two machines with the Balanced Interflex circuit. The performance of the circuit is wonderful. Am writing because we had trouble in tracing your circuit on page 443 of RADIO NEWS for October. We whipped it out by following the complete circuit on page 442.

Yours truly,

GUY SHUTER,
631 Park Avenue,
Piqua, Ohio.

Awards of the $50 Radio Wrinkle Contest

First Prize

A NOVEL SHORT-WAVE CONDENSER

By RICHARD G. ROFELTY

The condenser shown embodies many features desirable for short-wave work. The insulating material is kept well out of the electrostatic field, and the plates are arranged in a manner which minimizes body-capacitance effects, because they are perpendicular to, instead of parallel to the panel.

The materials required are: Two pieces of sheet brass, cut as shown in Figs. 1 and 2, three pieces of some highly-insulating material, of the dimensions shown in Figs. 3, 4, and 5; brass rod, ¼-inch diameter, 4 inches long; screws, solder, etc.

The insulating pieces shown in Figs, 4 and 5 may be of any convenient thickness; 3/16-inch will do. The piece shown in Fig. 3, however, should be thicker, preferably ⅜-inch, as it gives rigidity to the instrument.

After cutting the plates they may be bent into shape around any firm cylindrical object which is 2½ inches in diameter. The rotary plate should be bent first. Then a few layers of paper should be wrapped around the form, to make up for the difference in radius between the two plates. When the plates have been shaped, carefully bend the lugs until they are perpendicular to the axis of the instrument.

The condenser may be assembled easily, by referring to Fig. 6. The shaft is soldered to the lugs, and a pigtail connects it to the upper rear binding post; the stationary plate is connected to the lower binding post. A washer, slipped over the rod at the rear before the pigtail is soldered, acts as a bearing to take up end play. The slotted holes (shown in Figs. 4 and 5) allow adjustment of the distance between the plates. If the capacitance is raised to a point at which there is danger of the plates touching, a thin sheet of mica may be shellacked over one of the plates. This will serve as well to increase the capacitance considerably, because of its high dielectric constant.

The builder may, if he wishes, substitute his own dimensions, as the capacitance of such a condenser is always adjustable. The one shown can be expected to give a maximum of .00015 *μf.* without bringing the plates dangerously close together. This is ample for most short-wave work.

Prize Winners

First Prize $25

A NOVEL SHORT-WAVE CONDENSER

By RICHARD G. ROFELTY
305 S. Catalina St., Pasadena, Cal.

Second Prize $15

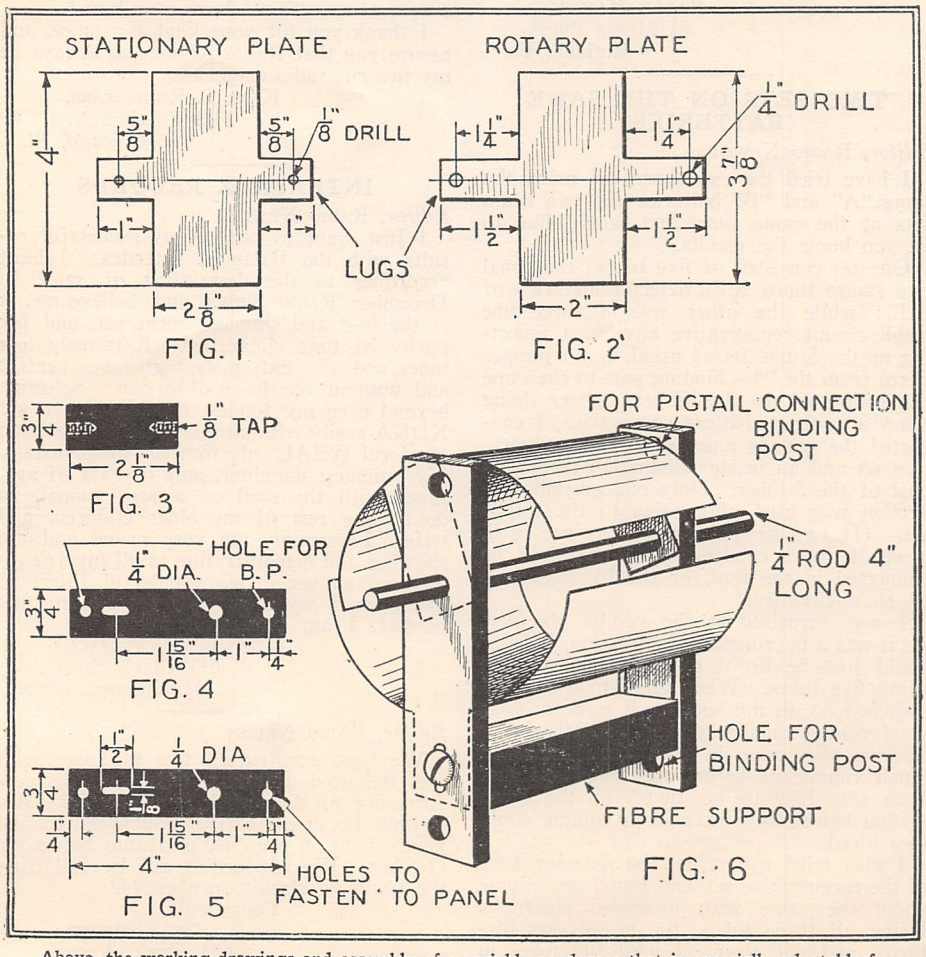
WINDING FORM FOR SOLENOIDS

By THOMAS C. McCOY
214 Audubon Ave., New York City

Third Prize $10

TWO WRINKLES WITH FILAMENT CONTROL JACKS

By MORRIS POOL
216 Miller Ave., Mill Valley, Cal.



Above, the working drawings and assembly of a variable condenser that is especially adaptable for short-wave work. Body capacity effects are greatly reduced because the plates are perpendicular to the panel

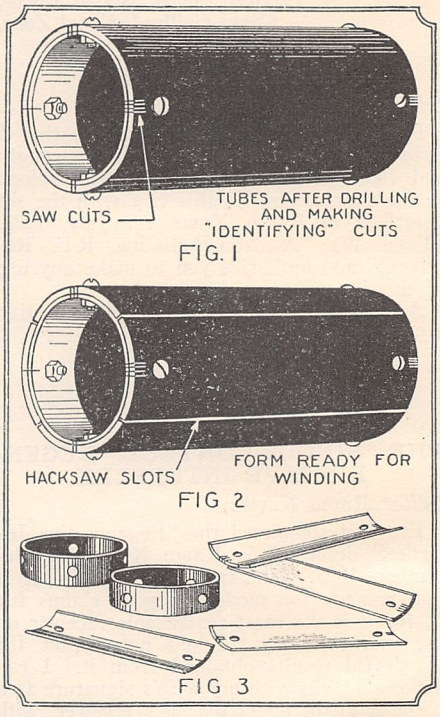
Second Prize

WINDING FORM FOR SOLENOIDS

By THOMAS C. McCOY

Engineers have convinced us by now that the spaced, air-wound solenoid is the most efficient form of coil. It is desirable, whenever possible, to make up such a coil with a minimum of supporting material. None of the usual winding forms, however, provides for this type of coil.

The accompanying illustrations show how a form may be made to provide for the manufacture of air-wound solenoids. Three



The sketch illustrates the method of constructing a form on which air-wound coils can be easily made.

pieces of insulating tubing are required. One is 6 inches long, 3 inches in diameter, with ⅛-inch wall; and two 1 inch long, 2¾ inches in diameter, with 1/16-inch wall.

Place one of the smaller tubes in each end of the long one, flush with the rim, and bore four holes, quartering the tube, each hole in line with the corresponding hole at the opposite end. This makes eight holes in all. Before dis-assembling, put bolts in the holes and mark the sections with saw cuts at the rim, cutting both the inner and the outer tubes, as shown in Fig. 1. This will aid in reassembling the parts after the form is completed.

Now remove the end pieces and with a hacksaw make four complete cuts axially down the long tube, between the holes, dividing it into four segments. These segments, as well as the end supporting rings, should be rubbed down with fine emery paper, in order to facilitate removing the completed coils.

When all the preliminary work is completed the form is again assembled, using 6-32 by ½-inch bolts. The identifying saw slots in the end make it easy to put the pieces back together in their original relationship.

The coil may now be wound on in the usual manner, either in a winding machine or by hand. The turns may be spaced by

the winding machine, or by string later removed, before collodion is applied to hold the turns and make the coils rigid.

After the collodion has dried the screws are taken out, the end rings removed, and the sectors of the long tube dis-assembled. If the collodion has not been applied with too lavish a hand, they should come out readily.

This form is long enough to permit two 70-turn coils of the usual wire sizes to be wound at the same time.

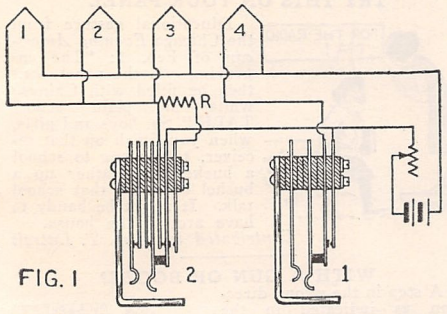
Third Prize

TWO WRINKLES WITH FILAMENT CONTROL JACKS

By MORRIS POOL

When building multi-tube sets, it is often desirable to operate all tubes from one rheostat. When this is done, and filament-control jacks are incorporated to cut out one or more A.F. stages, the voltage on the rest of the tubes is raised, and the rheostat must be turned back to reduce it to normal.

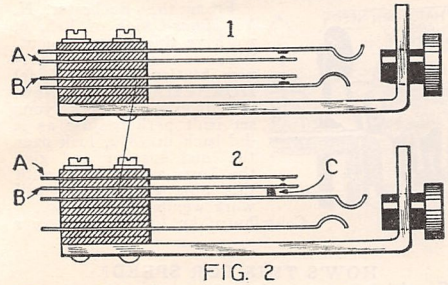
If, however, another filament-control jack No. 2, is hooked in (as shown in Fig. 1) with a resistance of the proper value, then



By inserting a resistance R, in the filament circuit when tube 4 is cut out, it does not overload the other tubes.

changing the phone plug from jack No. 1 to No. 2 cuts out tube No. 4, and cuts in the small resistance.

This resistance, R, may be another rheostat, an auxiliary resistance unit, or it may be made by the builder. Its value need not be more than four or five ohms; and when once adjusted, it need not be touched again



The method of making an open circuit filament-control jack from a double-circuit jack is here illustrated.

unless the voltage of the battery falls away below normal.

The use of this idea in a set simplifies its operation considerably; as the rheostat need not be touched, when plugging from one stage of A.F. to two, or vice versa.

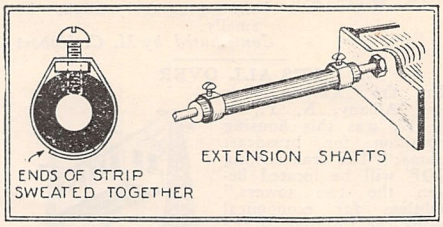
A very satisfactory open-circuit filament-control jack (Fig. 2) can be made from a double-circuit jack, by taking out the two center springs (A and B, whose regular arrangement is shown at No. 1) and replacing them above the outside springs, as shown at No. 2. It will probably be necessary to use extra insulating spacers and longer screws.

The spacers and the little insulating block, C, may be made of cardboard, fibre, or any other material with fair insulating properties. The block may be secured to one of the springs with glue or shellac, or any other way that is most convenient.

This jack is very useful for opening the filament circuit of the last tube when the plug is removed.

EXTENSION SHAFTS FOR SHORT-WAVE WORK

Anyone who has tried it knows the difficulty to be encountered in making extension shafts of insulating tubing for short-wave work. Usually a piece of brass rod, the same size as the instrument shaft, is inserted in the front-panel dial; and the two shafts



When following this method of connecting an extension shaft to a condenser, there is no danger of the shaft splitting.

are inserted in the ends of a length of tubing made from some insulating material, being held by set screws.

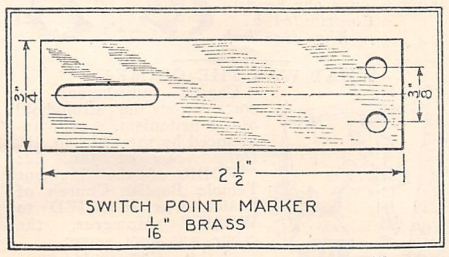
But when the set screws are tightened enough to keep the shaft from slipping, the tubing is apt to split. The trouble may be overcome in the manner shown in the accompanying diagram. Procure two pieces of strip brass, about three-quarters of an inch longer than the diameter of the tubing to be used, and two square brass nuts, with short screws to fit. Tin both sides of the brass strips and one side of each nut. Drill a hole in the center of each strip, large enough to pass the machine screws. Drill a hole of the same diameter near each end of the tube. Then sweat the nuts to the strips, keeping two edges perpendicular to the length of the strips, and centering the holes in the strips carefully over the holes in the nuts. Bend the ends around the tube and sweat them together, forming a complete snug collar at each end. The extension shaft may then be fitted to the regular shafts, and the screws tightened. It will be seen that by this method all strain on the tube itself is removed, yet the collars form a very firm and permanent means of holding the extension shaft rigidly.

Contributed by A. R. Hudson.

SWITCH POINT MARKER

The fan whose workshop does not contain a variety of precision tools finds it difficult to make a neat job of drilling for switchpoints. Usually the finished row of holes is very much out of alignment and does not form the perfect arc of a circle which it should.

A little time spent in making a switchpoint marker will be repaid in future convenience. Take a strip of brass $\frac{1}{16}$-inch in thickness, $\frac{3}{4}$-inch in width, and $2\frac{1}{2}$ inches long. Drill two holes near one end, exactly $\frac{3}{8}$-inch apart, center to center, and equidistant from a line marked down the center of the strip. At the other end of the strip drill a row of holes on the center line, and with a file or fine metal saw cut out the metal between them to form a slot as shown in the drawing.



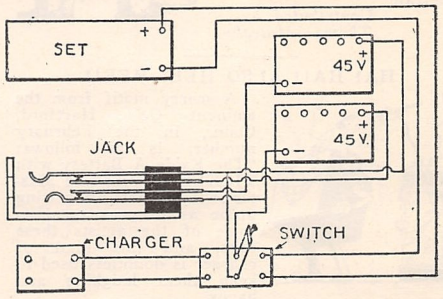
The switch-point marker here shown will save the set builder much time in panel layout.

The holes should have a diameter slightly greater than that of the switchpoint shanks which you intend to use, as a general rule. The spacing between the holes is correct for switchpoints with heads of $\frac{1}{4}$-inch diameter or less. As the shafts of most switches vary in size, it is best to make the slot of the same width as the other holes, and use a switchpoint like the others to locate it until the holes are drilled for the points. Then the hole for the switch shaft can be enlarged to the proper size for the bushing to be used. The slot allows the use of the marker for switches with blades of varying length.

Contributed by Wilfred P. Weathers.

SERIES-PARALLEL "B" BATTERY SWITCH

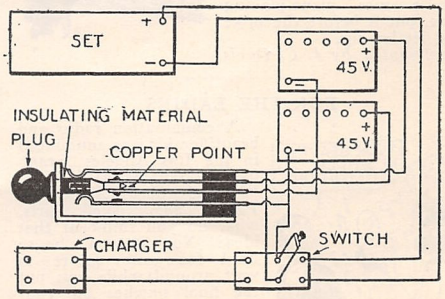
An ordinary four-tip jack is used for this purpose, with a plug of some insulating material (hardwood is satisfactory) having a copper point. The diagrams show clearly the connections.



This sketch shows the "B" batteries connected in shunt for charging which occurs when the DPDT switch is thrown to the left.

In the upper figure the plug has been removed and the two 45-volt "B" batteries are connected in parallel for charging.

In the lower figure, the plug has been inserted and the batteries are connected in series for use.



With the plug inserted and the switch thrown to the right the batteries are connected in series to the set.

The double-throw switch, as shown, connects the batteries with the charger or with the set, when desired.

Contributed by H. de Miffonis.

CHECKING ASSEMBLY

Man is human and as the proverb says, "To err is human." So, to locate and remedy possible defects in the building of any receiver, the builder will find it useful to follow a logical system of investigation.

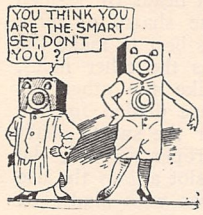
Connect the storage "A" battery to the correct phone-tip jacks and insert a tube in socket and note if it lights. Then try it in all of the sockets. First—If your tube does not light, trace the current from the phone-tip jack, through the switch, sockets, rheostats, amperites, and on back to the battery. There may be a bad contact at any one of these places, or possibly an amperite may have burned out.

Then connect the storage "A" battery to

(*Continued on page* 1605)

—RADIOTICS—

FLANNELS OR BVDS?



Item from the Lewiston, Maine, *Daily Sun* of Feb. 11: "Sets having 8 or more tubes generally give a lot of noise even if the input circuit is SHIRTED so that no static can get in." Circuits, that have heretofore been covered with patents, can now be covered with cast-off BVDs, or what you will.

Contributed by C. E. March

FOR YE BOOTLEGGER

Ironical gesture from the *Toronto Daily Star's* advertising columns, on Feb. 12: "GRIP LEAKS—.20". We suppose that these gadgets are a special arrangement for the handy little bags that all good bootleggers and true use, so that the evening's entertainment will not drip and bring a cop on the trail.

Contributed by Thomas Mulcahy

HA! HA!! ALSO HEE! HEE!!

A merry motif from the eminent *QST*, Hartford, Conn., in the February number, is as follows: "The Exide A Battery with TICKLE Charger and Master switch." Sets are getting to be as temperamental as some of the artists these days, and this kind of charger is doubtless used to keep them laughing and happy.

Contributed by Lyman F. Barry

OUR NEXT NUMBER——

Musical announcement from the Pittsburgh, Pa., *Press* of Jan. 29: "All Tubes guaranteed to light and PLAY." That makes it pretty soft, we'll say, for the broadcasters. Whenever an artist does not show up, all they have to do is to dig down in the tube box and get a nice piano-playing tube, put it before the mike and let 'er rip.

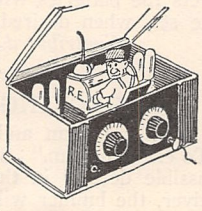
Contributed by J. C. Davis

FOR THE LADIES

A combination radio and beautifier kit was announced in the Los Angeles *Examiner* of Jan. 31 as follows: "New 5 tube A.K. COMPACT, $85." Well, girls, what do you think of that idea? Now it won't be so hard for your escort to wait around while you put the final touches on your complexion at the dinner table, as there will be something to keep him awake.

Contributed by Hugo Kinner

HE KEEPS HIS FEET ON IT



In the February issue of *QST*, Hartford, Conn., was the following item about radio furniture: "The small DESK in the center of the set is a miniature honeycomb coil used as the R.F. choke." No, Oscar, we don't know what the desk is for, but we've a hunch that maybe it's for the engineer who directs the currents in the set.

Contributed by Dana G. Barber

WHAT NEXT?

Scientific item from the Altoona, Pa., *Tribune* of Jan. 1: "The power of station WAHG is 500 WORDS." We suppose that this discovery of the wondrous power of words will in time revolutionize the radio industry, and soon we shall see stations that are limited to so many words per day. In some cases it would help greatly.

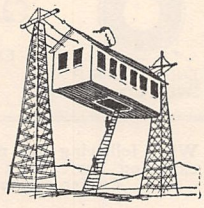
Contributed by John Finn

THAT'S THE DOPE

Medicinal suggestion from the Chicago *Evening Post* of Jan. 28: "If the floor is not covered with DRUGS the sound is likely to echo back and forth to the ceiling—." So, those of you who broadcast, give heed to these words of wisdom. But let us add a word of precaution—don't tell your artists what the *dope* is or the programs might be smelly.

Contributed by M. C. Hobart

IT'S ALL OVER



In the *Knickerbocker Press*, Albany, N. Y., on Jan. 17, was this housing proposition for broadcast stations: "The transmitting ROOF will be located between the two towers." Doubtless for economical reasons the tin roof of the station will be used as an antenna, thereby saving a few shekels for someone. Oh, these brainy engineers!

Contributed by T. F. Maher

SO'S YOUR OLD OPERATOR

In the catalog of the Chas. Williams Stores, New York City, appeared the following: "This performance—of the set—depends on the—atmospheric conditions, height and length of the OPERATOR." We suppose that the next step in radio development will be that sets will be made to fit each individual operator. Ah, well, we must have something new.

Contributed by Stanley C. Page

IF you happen to see any humorous misprints in the press we shall be glad to have you clip them out and send to us. No RADIOTIC will be accepted unless the printed original giving the name of the newspaper or magazine is submitted with date and page on which it appeared. We will pay $1.00 for each RADIOTIC accepted and printed here. A few humorous lines from each correspondent should accompany each RADIOTIC. The most humorous ones will be printed. Address all RADIOTICS to

Editor RADIOTIC DEPARTMENT,
c/o Radio News.

WUXTRY! WUXTRY! MANUFACTURERS EXPOSED!

Startling exposure by the *Detroit News* of Jan. 31, which has the following statement: "——dirty tube CONTRACTS will also give trouble of this nature." Now we know where all the howls and things come from; it's from these fellows that make trick contracts with us poor B. C. L.'s and then gyp us. Oh, migosh, this is a hard world!

Contributed by Francis E. Norgard

NEWS FROM THE FRONT

Casualities reported in the *McPherson Radio* catalog, Montreal, Canada: "Three circuit tuner, WOUNDED with litz and green silk covered wire." Evidently someone who was building a set got mad at the tuner and shot it in the rotor with a litz bomb. Why they want to sell such a thing is over our heads.

Contributed by Wm. Hanchuk

WHAT WAS THE CRIME?

Capital punishment reports from the stronghold of Puritanism, as announced by the Chicago, Ill. *Daily News* of Jan. 22: "WDBR of the Tremont Temple Baptist Church of Boston was HANGED to WSSH." However, the crime was kept secret.

Contributed by Emil G. Cepuder

FOR THE DIABOLICAL FIVE

Under the head "Much Progress in New Tuning-coil Designing" the Los Angeles *Evening Express* of Nov. 26 had the following gem: "Fasten the FIRES on one side with a strip of adhesive tape and then bend the coil around in the form of a circle." Surely the gent that designed that sort of coil expects to go down where they don't need overcoats in winter—and we don't mean Palm Beach either.

Contributed by Geo. P. Fuller

ANOTHER CASE OF PROHIBITION?

Doings in radio from the native heath of Uncle Sam. In the Dec. 31 issue of the U. S. government *Radio Service Bulletin*, there is this headline: "Broadcasting Stations Equipped so as to Suppress HARMONIES." We should think that by this time the intelligentsia that dispose so lightly of national affairs would realize that people like to hear good music, instead of some of the stuff that struggles in through the loud speaker.

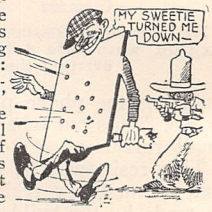
Contributed by H. J. Ridge

TRY THIS ON YOUR PANEL

Educational gesture from the Chicago *Evening American* of Feb. 1: "The engravings on the panel—can then be filled with Chinese white or plain school TALK." So, boys and girls, when you finish up that receiver, take along to school a bucket and gather up a bushel or so of that school talk. It might be handy to have around the house.

Contributed by Wm. T. Littrell

WITH A GUN OR BOOZE?



A step in the wrong direction as indicated in the March issue of RADIO NEWS in the Ambu Engineering Institute's advertisement: "SHOT subpanel makes assembly quick and easy." No, Bud, we really are quite unaware if the panel has been freely imbibing of the cup that cheers, or has been staging a wild west show. Of course it could be a little of both, eh, what?

Contributed by Mrs. F. H. Richardson

HERE'S A NEW ONE

From the Rochester, N. Y. *Times-Union* of Feb. 6, we have this advertisement, "We are the authorized Service Station for the Kodel HORNCHARGER." Now, Grandpop, whenever your set isn't perking just as it did back in 1872, look over the loud speaker and give the horn a little pep with this new gadget. It will work wonders, we know.

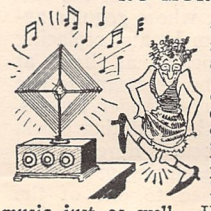
Contributed by John C. Heberger

HOW'S THIS FOR SPEED?

Spanish influence as shown in the *Canadian Radio Trade Directory* of 1925, in the following advertisement "Samson Neutralizing Condenser: Neutralizes in a few MONTHS; once set it stays set." Well we should hope that it would stay set after taking all that time to get it fixed at the proper place. Have patience, boys.

Contributed by W. J. Rowles

NO MORE WORRIES



From an advertisement in the *Radio Broadcast Advertiser* of February we have a set advertised with "Built-in LOOP Speakers." Now that's what we consider a step in the right direction. Away with all these worries of whether the loud speaker is feeling well tonight! The faithful loop will bring to your ears the music just as well. Hooray!

Contributed by E. W. Perkins

STANDARD HOOK-UPS

EVERY month RADIO NEWS presents in this convenient form a selection of circuit diagrams, with constructional and other data, on standard hook-ups, which the editors have tried and found to give excellent results. Every radio experimenter should preserve these for their reference value, as they are selected to cover the complete range of radio apparatus, from the simplest to the largest and most complicated. Requests for special or additional advice and information should be addressed to the I WANT TO KNOW Department of RADIO NEWS. (A charge of 25 cents is made for answering each question which requires a reply by letter.)

Handy Reference Data for the Experimenter

SPECIAL REINARTZ RECEIVER

Circuit No. 159. The following is the Reinartz circuit (tuner) to which has been added one stage of radio and one stage of audio frequency amplification besides the detector. The extreme satisfaction obtained from the Reinartz receiver is very well known to the average set constructor. Its advantages are enhanced by the above-mentioned additions, and the results obtained will be very satisfactory.

The construction of the tuner is as follows: L1 is wound on a tube 3 inches in diameter and approximately 4 inches in length, and consists of 51 turns of No. 22 D.S.C. or D.C.C. wire, and tapped at the 40th turn. L2 is wound on a tube 2¾-inches in diameter and about 3 inches in length, and consists of 45 turns of the same size wire; it is placed within L1 and mounted in permanent fashion. C1, C2 and C3 are .0005-μf. variable condensers, preferably of the straight-line-frequency type to obtain good results, and better tuning on the shorter wave-lengths. The radio frequency transformer is not home-made. It is of the untuned type, similar to the Acme R2 or R3, All American, Erla, etc., which may be purchased in any retail radio store. One of the iron-core type, designed for use on the broadcast range—200 to 550 meters—should preferably be used. The potentiometer is of the 400-ohm type; and the audio frequency transformer either of 5-to-1 or 3½-to-1 ratio.

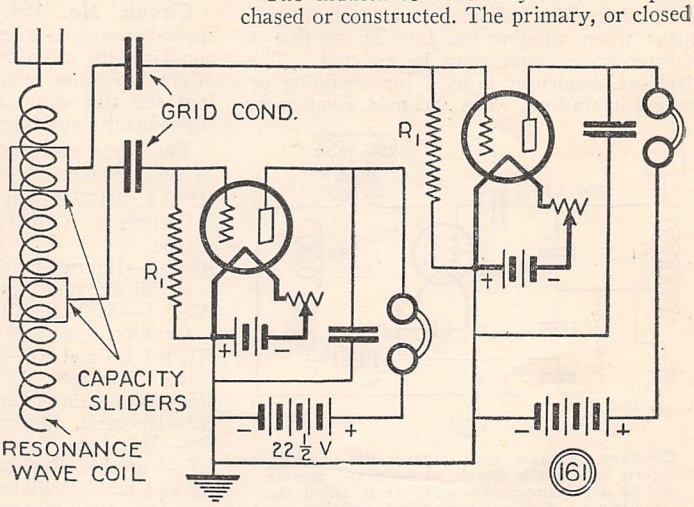
LOW-POWER TRANSMITTER

Circuit No. 160. Because of the enormous number of questions received concerning an efficient low-power transmitter, we are herewith showing one that operates exceedingly well on low power and for use as a speech transmitter. The circuit incorporates what is popularly known by the transmitting amateur as the Heising system. This is practically the best system of modulation, which accounts for the unusual efficiency of this circuit as a radiophone transmitter.

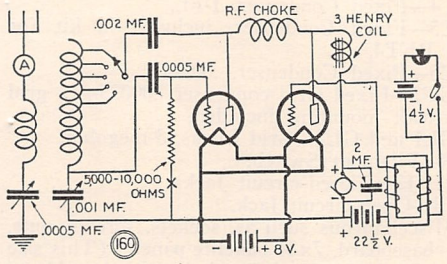
The parts necessary are as follows:

1 Transmitting-type condenser, .0005-μf.,
1 Transmitting Grid Leak, 10,000-ohm, with center tap at 5,000 ohms,
1 By-pass Condenser, transmitting type, .002-μf.,
1 Choke Coil, 3-henry,

Herewith is shown a unique circuit which permits simultaneous reception of two wave-lengths, by employing a single antenna and ground system, and a single tuning unit. This circuit is deserving of some experimentation by those who are interested in a receiver having this characteristic.



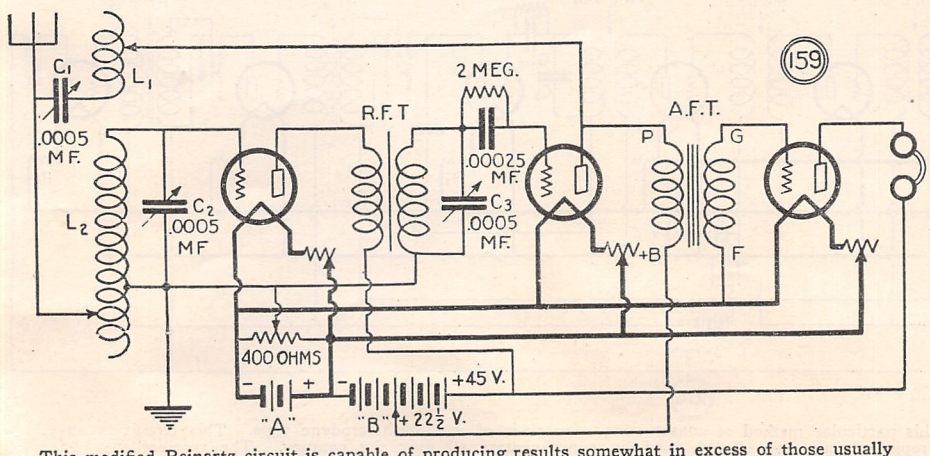
1 R.F. Choke Coil, which may be a 300-turn honey-comb coil, or 200-turn No. 26 D.C.C. wire wound on a 2-inch tube,
2 5-watt or the new UX-210 (7.5-watt type) tubes,



An efficient and popular low-power amateur transmitter for both phone and C.-W. work, employing the Heising system of radiophone modulation.

1 Modulation Transformer (which may be an ordinary Ford spark coil whose vibrator has been turned down tight),
1 Variable Condenser .001-μf., transmitting type,
1 Fixed Condenser, .0005-μf.

The inductance coils may either be purchased or constructed. The primary, or closed operatory circuit coil consists of approximately 20 turns of No. 14 wire space wound on a 3-inch tube; the secondary, or antenna coil, consists of 6 turns of No. 14 wire, space-wound on a 2¾-inch tube, which slides in and out of the secondary coil and thereby allows flexible adjustment of the coupling between the two circuits. The larger coil should be tapped every turn, so that the transmitter may be operated on the extreme short-waves (40-meter), or the conventional radiophone wave on which best results are obtained, approximately 195-meter. In adjusting this transmitter, the switch lever controls the wave-length in conjunction with both variable condensers which are rotated slowly until maximum radiation is indicated in the ammeter. For C.W. a key may be placed as indicated or at X; in which case it is necessary to substitute a high-pitched buzzer for the microphone.



This modified Reinartz circuit is capable of producing results somewhat in excess of those usually obtained from the popular Reinartz receiver, due to an addition of one stage of untuned radio-frequency amplification.

SIMULTANEOUS RECEPTION OF TWO WAVE-LENGTHS

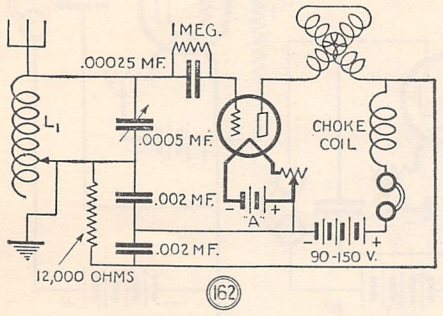
Circuit No. 161. The following shows a system whereby two stations may be received with a single antenna and inductance coil, and distribute to two different tubes and headsets. By this method it is possible to receive two broadcast stations whose programs are both desired; or to determine which of the two is preferable, and then turn out the tube which is operating on the other station.

The coil used is of a special type, is technically termed a "resonance-wave" coil, whose particular characteristic is that by virtue of its distributed capacity it has a natural frequency of resonance comparable to the frequency of the received energy. It should be wound in a single layer with No. 28 D.C.C. wire on a 3½-inch tube, approximately 24 inches long, and over it a *single layer* of empire paper. The slider is an ordinary narrow strip of either sheet zinc or aluminum, which is bent around and slides

snugly over the coil, at the end of which is left a narrow slit, about ⅛-inch, so that it will not be like a complete turn of a coil whose ends are short-circuited. The slider moves back and forth on the coil, and in this manner tunes in various stations. R and R1 are ordinary variable grid leak resistances, having a variable range of from ¼- to 10-megohm. The grid condensers should be of .00025-μf. each.

BISHOP SUPER-REGENERATIVE CIRCUIT

Circuit No. 162. This circuit is a modification of the popular Flewelling receiver. It is somewhat simpler to build and adjust; and if made properly will give equal efficiency. The inductance L1 consists of 45 turns of No. 20 D.C.C. wire wound on a 3-inch tube. This coil may be tapped every 5 turns when winding the last 20, so that a shorter-wave range may be covered. The .0005-μf. condenser is used for obtaining or tuning in stations. The .002 mfd. condensers



Contrary to most super-regenerative circuits, here is one that is simple to build and operate and is not "temperamental." It is called the "Bishop Super-Regenerative" circuit.

should be of the mica-dielectric type; as the paper type will vary in capacity and in this manner decrease the efficiency of the receiver. The resistance connected across the two fixed condensers should be approximately 12,000 ohms; although for best results we would recommend that the constructor obtain a variable resistance covering a range of from 2,000 to 25,000 ohms. The variometer is used for controlling regeneration, and in this manner the volume also of the stations obtained. The choke is a 300-turn honeycomb coil.

BROADCAST AND C.W. RECEIVER

Circuit No. 163. This circuit illustrates a variation from the usual methods of obtaining broadcast and C.W. signals. This system incorporates a resonance-wave coil, and a heterodyne oscillator. By using the "Best method" of reception, C.W. signals may thereby be obtained. Broadcast reception is also obtained with this receiver, similar to that from the super-heterodyne type. The oscillator makes use of a 50-turn coil, with a tap at the 25th turn, wound on a 3-inch tube. This coil is L2 on the circuit diagram. L3 is a 15-turn winding on the same tube that L1 is wound on; L1 consisting of 25 turns wound on a 2¾- or 3-inch tube. The constructional data for the resonance wave coil and sliders are similar to those of Circuit No. 161. C1, C2 and C3 variable condensers (.001-μf.). The radio frequency choke may be an ordinary 300-turn honeycomb coil.

BEST'S SUPER-HETERODYNE RECEIVE

Circuit No. 164. This very efficient super-heterodyne receiver has become very popular with radio constructors, and is here offered to those who have not as yet realized the full value and possibilities of the super-heterodyne type of circuit.

The parts necessary for the construction of this receiver are as follows:

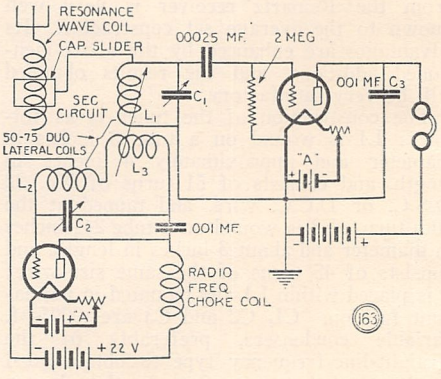
RFT-1, RFT-2 and RFT-3—Intermediate-Frequency Transformers, 50-kc. untuned type.
RFT-4—Intermediate-Frequency Transformer, 50 kc. tuned type.
AFT-1—AFT-2—Audio frequency transformers, low ratio,
R1, R3, R4 and R8—Automatic filament-control cartridges,
R5—Automatic filament-control cartridges,
R2—Rheostat, 30-ohm,
R6—Grid Leak, 1-megohm
R7—Variable Resistance, 0-5,000-ohm,
L1 and L2—Oscillator Coils, purchased with intermediate-frequency transformers in kit form,
VC1, VC2, VC3, GC1—Variable Condensers, 0005-μf.,
C1 and C2—Fixed Condensers, .006-μf.,
C3—Fixed Condenser, 0.2-μf.,
C4—Fixed Condenser, 1-μf.,
C5—Fixed Condenser, included in kit for RFT4,
C6—Fixed Condenser, .002-μf.,
GC2—Fixed Grid condenser, .00025-μf., grid leak mounting included,
GL1 and GL2—Grid Leaks, 3-megohm,
S—Filament Switch,
J1, J2—Closed-circuit Jacks,
J3—Open-circuit Jack,
Miscellaneous such as, sockets, screws, nuts, baseboard, 7x24 bakelite panel. (This size may be changed, but it is not advisable to place the parts too close to each other).
V—Voltmeter (6-volt).

The oscillator coils should be of the plug-in type, so that the wave-length range may be varied. The loop should also be changed when it is desired to tune to extremely short wave-lengths, such as 50 to 200 meters. It is therefore, advisable that a quick "throw-over" switch be used, so that the loops may be changed without any loss of time. The short-wave loop should consist of only about 5 turns on the conventional loop frame.

UV-199 tubes are used in the three intermediate-frequency stages, and standard 6-volt tubes in the other sockets. The resistance R7 is a volume control; as the amount of resistance used is decreased, signals will become weaker. If the oscillator dial tunes too broadly the value of R6 should be increased to .25 or .5-megohm.

Where audio frequency transformers of different ratios are desired, for best results a 5-to-1 type should be placed in the first stage, and a 3- or 2½-to-1 type in the second stage.

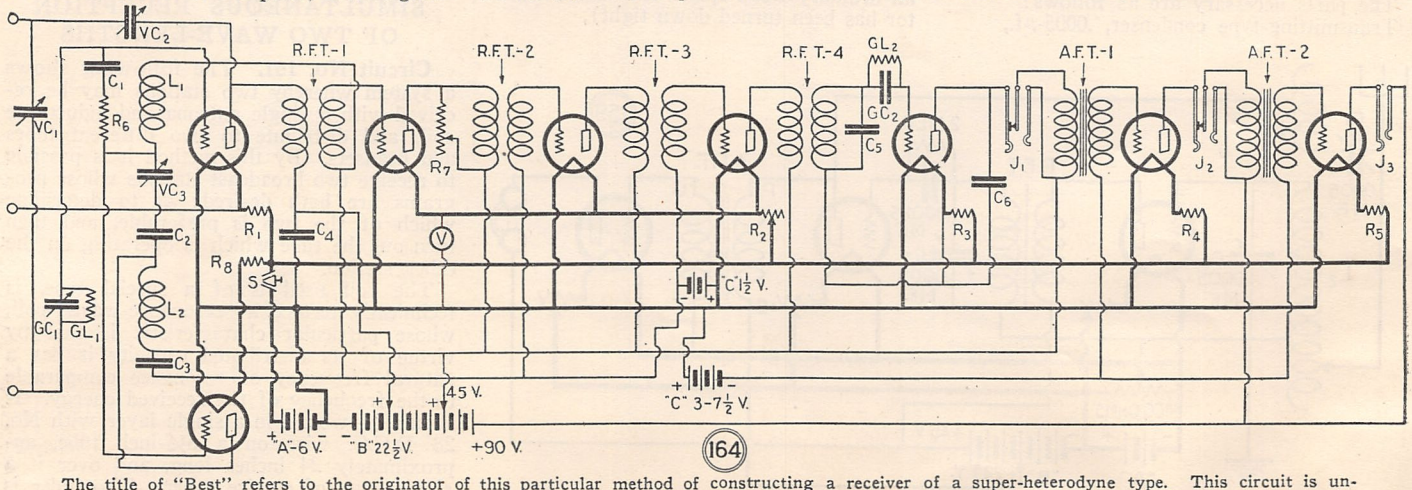
A UX-112 power type tube may be used in the last audio stage which will result in



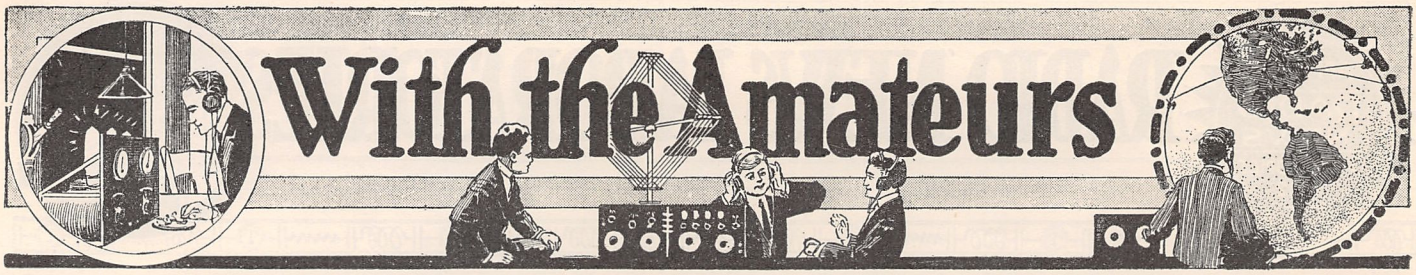
A circuit that employs a unique method for the reception of broadcast and continuous-wave signals by means of the "Heterodyne" or "Beat System," somewhat similar to the super-heterodyne set.

increased volume and better reproduction of signals. If smaller tubes or other types are used, it is essential that an automatic filament adjuster be used which is suitable for the particular type of tube to be used.

In the adjustment of this receiver, if no signals are received at first try reversing from the coils connections to either L-1 or L-2, do not reverse both at the same time. For best results try varying the amount of grid leak resistance used in the first and second detector circuits, especially when different type detector tubes are tried. The receiver will be found similar to other types of super-heterodyne receivers, the peculiarities of this set being similar to those that characterize other types. Although a variable grid condenser is shown in the first detector tube circuit, an ordinary .00025-mfd. grid condenser may be used with approximately just as satisfactory results.



The title of "Best" refers to the originator of this particular method of constructing a receiver of a super-heterodyne type. This circuit is unusually popular with West Coast fans; and is rapidly being adapted and tried by experimenters all over the country. The receiver may be built in compact or "portable form," so that it may be taken along on camping trips and tours; and used very successfully, as it operates efficiently on a small loop.



The Etiquette of Radio Transmission

By HENRY LAMONTE

AS ALL the amateurs who are interested in the transmission of radiophone know very well, a new band of wave-lengths has been opened up recently by the Government for their use. This band, which is 83.28 to 85.66 meters, will prove to be a curse instead of a boon, if the etiquette of the air is not more closely observed.

Sometime ago when the wave band from 170 to 180 meters was released to the hams for phone transmission, a cry of joy was raised to the heavens. "Now," said the hams, "we will have our own back yard to play in, and a good time will be had by all." Well, if you remember correctly a good time *was* had by all; that is, if you consider only the fellows who were on the air most of the time and who succeeded in jamming things till further orders. Theirs was the party, and no one else's.

It is against this jamming of the ether that this particular hue and cry is raised. Is there such a thing as etiquette of the air (or ether or whatever you want to call it); or do we have to class ourselves as fellows, who don't care what the other man gets, as long as we get ours? Surely the hams of this enlightened age do not wish to be classed with the robber barons of the middle ages in Europe. You will remember, from your schoolbooks, how the old boys used to swoop down out of their strongholds and pounce on some poor traveler, getting whatever they could. Those tactics were looked upon with repugnance, even in those days, by the fellows who took the dirty end of the deal; and it is just the same in these enlightened days of the Twentieth Century. We certainly do not look with pride and admiration upon a man who, by such robber-baron tactics, messes up the air for the fellows who are seriously trying to do something. Some old-time wisecracker said that might was right. That may be in some countries, but not here in the United States. Here we look with pride to the man who thinks of the other fellow once in a while. And remember this, fellows, you never can tell when you will be almighty glad to have someone to give you a hand, some time.

Now just what are some things that result in jamming up the air so that when the ham goes to bed at night, instead of retiring with a calm mind, he will seek the hay with curses trembling in his soul, and most likely spilling all over the room. Well, in the first place, there are the unnecessary communications, such as raising station after station and pulling the same old line with each one: "How am I coming in? How is my modulation?" You know, as well as we do, that about all the use some of the hams make of their outfits is to litter up the ether with such edifying transmissions. Now, for our part, we want to raise one grand and glorious howl against this practice. What under the sun, moon and stars and the rest of the upstairs world, is the use of spending good money for a bunch of transmitting equipment and then cluttering up things like that? We claim the use is nil, nothing, nix.

FAULTS OF PUNK OUTFITS

Of course it must not be thought that we are condemning those really serious hams, who are continually experimenting with their apparatus and who wish to find out if their modulation has been bettered by the changes they have made. That is indeed a horse with another collar; and the above denunciation was not directed at them—the hams, not the horse. We are knocking only those who deserve to be hammered, and we are sorry to have to say that there are entirely too many of them.

When it is considered that there are hundreds of stations working on two wave bands, that are but ten meters wide, the thought at once comes that, unless the utmost care is exercised in the handling of apparatus, greater confusion than ever will be the result. For instance, there is the fellow whose tuning is so broad, that if it was measured it would run the Mississippi River a close second. In the majority of cases this is caused by too-close coupling. Why not try about six or eight inches between the oscillator and antenna coils?

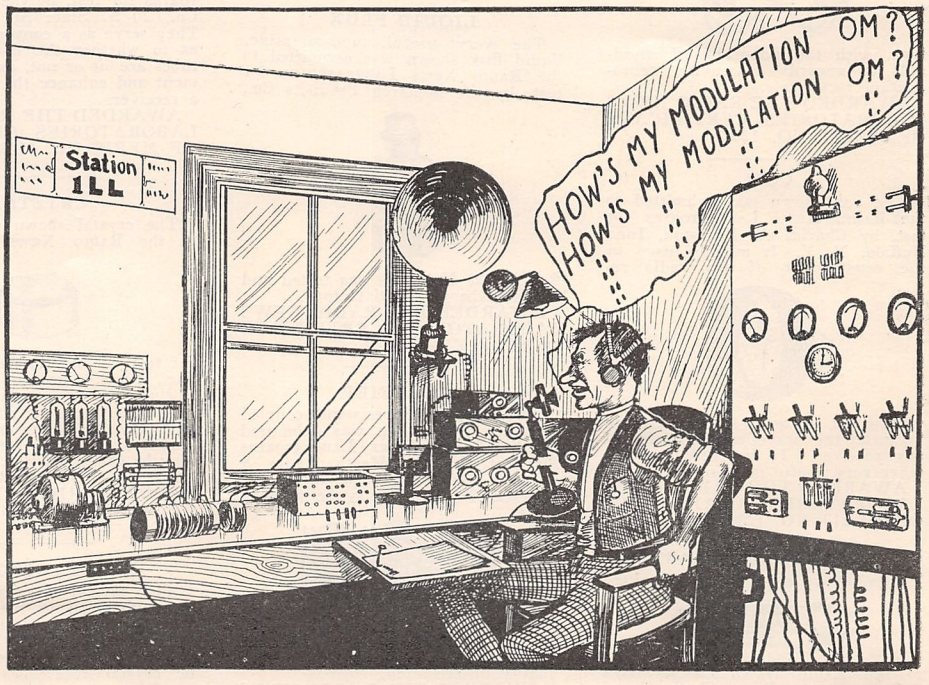
But these are not the only things that must be considered to prevent unnecessary jamming. The other night we picked up a station while we were listening in at a friend's house, and you should have heard that fellow's modulation. Instead of trying to get distance—he was calling someone three districts away—he should have been asking the question that we condemned so heartily a few paragraphs back. It was worse than awful. We called him and asked how his mike was. He replied that it was a third- or fourth-hand mike and take it all in all we believed him. It must have been the one that Noah used on the Ark.

HOW IS YOUR POWER HOUSE?

Of course there are many other causes of poor modulation. For instance, there is the common one of a poor power source. This, many times, is not the ham's fault; but if you have tried everything in your power to better your modulation, and it still persists in being N. G., take a good look at the old power plant. Then there is the gentleman who uses rectified A.C. for his current supply. Here is a case where the modulation is no better than his filter system, for a poorly-designed filter or one in which there are defective parts, will do more to produce poor modulation than anything else we can think of at the minute. Of course, when speaking of power units, the motor generator set should be mentioned; and here again is another source of modulation that is not all that is desired.

Motor generators are supposed to be the best when it comes to giving a pure D.C. note; but you fellows know, as well as we do, how often you get a pure note from a motor generator, when a filter is *not* among those present. Even when a M.G. is used with a brass pounder's outfit it is quite necessary to use a filter system. The filter system needed is not nearly so complicated as that required for smoothing out rectified A.C. All that you need is a 2-μf. condenser shunted across the output terminals of the generator. That is simple enough, isn't it? However, a necessity may arise in some transmitters for a little experimentation with the value of this condenser, before one

(*Continued on page* 1594)



". . . about all the use some hams make of their outfits is to litter up the ether with such edifying transmissions."

RADIO manufacturers are invited to send to RADIO NEWS LABORATORIES, samples of their products for test. It does not matter whether or not they advertise in RADIO NEWS, the RADIO NEWS LABORATORIES being an independent organization, with the improvement of radio apparatus as its aim. If, after being tested, the instruments submitted prove to be built according to modern radio engineering practice, they will each be awarded a certificate of merit, and a "write-up" such as those given below will appear in this department of RADIO NEWS. If the apparatus does not pass the Laboratory tests, it will be returned to the manufacturers with suggestions for improvements. No "write-ups" sent by manufacturers are published on these pages, and only apparatus which has been tested by the Laboratories and found to be of good mechanical and electrical construction is described. Inasmuch as the service of the RADIO NEWS LABORATORIES is free to all manufacturers whether they are advertisers or not, it is necessary that all goods to be tested be forwarded prepaid, otherwise they cannot be accepted by the Laboratories. Apparatus ready for the market or already on the market will be tested for manufacturers, as heretofore, free of charge. Apparatus in process of development will be tested at a charge of $2.00 per hour required to do the work. The Laboratories will be glad to furnish readers with technical information available on all material listed here on receipt of a stamped envelope. The Laboratories can furnish resistances of the various instruments, amplification curves of transformers, losses in condensers, etc., and other technical information. Address all communications and all parcels to RADIO NEWS LABORATORIES, 53 Park Place, New York City.

SOCKET

This socket was submitted to the RADIO NEWS LABORATORIES for test, by the Pacent Electric Co., 91 Seventh Ave., New York. It is made of the lowest-loss material obtain-

able, isolantite, and has some very unique features which will undoubtedly appeal to those who use it. It may be used for any standard type of vacuum tube now on the market.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1273.

HEAD PHONES

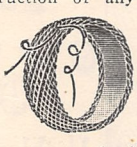
These head phones were submitted to the RADIO NEWS LABORATORIES for test, by Hart & Hegeman, Hartford, Conn., and have been found to con-

form with the Laboratories' standards as regards sensitivity, reproduction factor, etc.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1201.

COIL

The coil shown was submitted to the RADIO NEWS LABORATORIES for test, by Charles A. Branston, Inc., Buffalo, N. Y. It may be used in the construction of any radio re-



ceiving set or as a loading coil to increase the wave-length range of any receiver. It can serve several other very useful purposes.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1200.

FILAMENT BALLAST

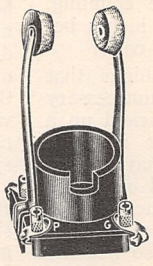
The device shown was submitted

to the RADIO NEWS LABORATORIES for test, by the Daven Radio Corp., 158 Summit St., Newark, N. J. It has been found satisfactory for controlling the filament temperature of several tubes connected in parallel within a receiving set.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1185.

SOCKET

This unusual socket was submitted to the RADIO NEWS LABORATORIES for test, by the Bremer-Tully Mfg. Co., 532 S. Canal St., Chicago, Ill. It may be used in conjunction with any of the standard type tubes now on the market; it has special side shock



absorbers for the radio tube which prevent mechanical tube noises.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1333.

LIQUID FLUX

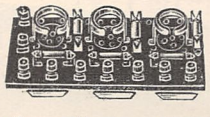
The very useful, non-corrosive, liquid flux shown was submitted to the RADIO NEWS LABORATORIES for test, by the Monarch Products Co.,

Red Bank, N. J. It was tested and found to be very satisfactory.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1196.

AMPLIFIER

The three-stage resistance-coupled amplifier unit shown was submitted to the RADIO NEWS LABORATORIES for test, by the Heath Radio & Electric Mfg. Co., 206 First St., Newark, N. J. It may be used in

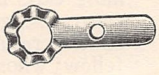


conjunction with any detector unit, and is capable of an unusually high quality of reception.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1218.

LUGS

This unusual terminal or lug was submitted to the RADIO NEWS LABORATORIES for test, by the A. F. Henninger Corp., 4509 Ravenswood Ave., Chicago, Ill. It may be used in the construction of receiving sets, and has the unique characteristic of

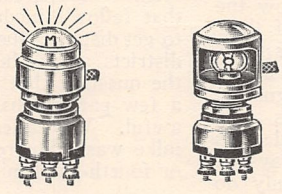


a combined lock-washer and lug, which prevents the nut from loosening and facilitates improved connection.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1205.

PILOT SWITCH AND DIALITE

The instruments shown were submitted to the RADIO NEWS LABORA-



TORIES for test, by the Carter Radio Co., 20 S. State St., Chicago, Ill. They serve as a convenient indicator as to whether the filaments of the tubes are lit or not, as well as ornament and enhance the appearance of a receiver.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1183 and 1184.

CRYSTAL

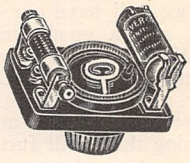
The crystal shown was submitted to the RADIO NEWS LABORATORIES

for test, by the Reynolds Radio Co., Inc., 10 S. Chestnut St., Colorado Springs, Colo. It was found to be very sensitive, and may be used in any crystal receiving set. It is mounted in good form so that it may be easily adapted.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1191.

DETECTOR

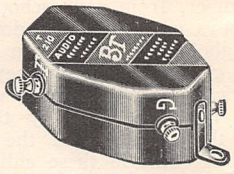
The crystal detector unit shown was submitted to the RADIO NEWS LABORATORIES for test, by the Carborundum Company, Niagara Falls, N. Y. It may be used in any reflex or crystal receiving set; and has special means of controlling volume and increasing sensitivity of the crystal by means of a dry-cell battery and variable resistance, which is included within the unit.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1212.

TRANSFORMER

This audio frequency transformer was submitted to the RADIO NEWS LABORATORIES for test, by the Bremer-Tully Mfg. Co., 532 S. Canal St., Chicago, Ill. It may be used in the construction of any audio amplifier, or receiving set in which audio am-

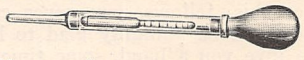


plification is used. It has a remarkable reproduction and volume factor.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1330.

HYDROMETER

The hydrometer shown was submitted to the RADIO NEWS LABORATORIES for test by the Robert Bosch

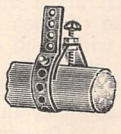


Magneto Co., 123 W. 64th Street, New York. It is a very useful instrument and carefully calibrated for testing the condition of the storage battery.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1177.

GROUND CLAMP

The ground clamp shown was submitted to the RADIO NEWS LABORATORIES for test, by the Blackburn Specialty Co., 1965 E. 66th Street,

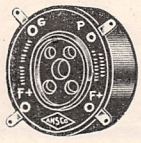


Cleveland, Ohio. It operates on a new and different principle and insures better ground contact.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1215.

SOCKET

This socket was submitted to RADIO NEWS LABORATORIES for test, by Amsco Products, Inc., Broome and Lafayette Sts., New York. It adapts itself readily to receivers where space is at a premium and



its features are distinctively economic from the point of view of space saving.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1266.

TRANSFORMER

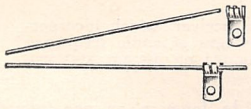
The audio transformer shown was submitted to the RADIO NEWS LABORATORIES for test, by the Electrical Research Laboratories, Inc., 2510 Cottage Grove Ave., Chicago, Ill. It was found to be of unusual design and capable of amplifying cur-

rent of audio frequency without distortion. It may be used satisfactorily in the construction of any radio receiver which contains transformer-coupled amplification.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1168.

UNIVERSAL TERMINALS

These handy connectors were submitted to the RADIO NEWS LABORATORIES for test, by L. S. Williams, 1210 Parkside Blvd., Toledo, Ohio,

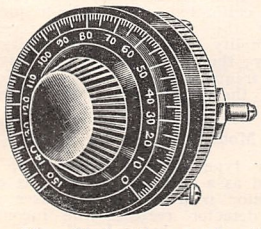


and proved readily adaptable to the countless exigencies present in radio receiver construction.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1070.

VARIABLE RESISTANCE

This rheostat was submitted to the RADIO NEWS LABORATORIES for test, by Electrad, Inc., 428 Broad-

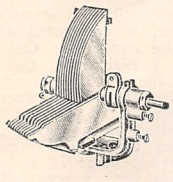


way, New York. It was found to be very close to its rating.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1265.

CONDENSER

The condenser shown was submitted to the RADIO NEWS LABORATORIES for test by the Hammarlund Mfg. Co., 424 West 33rd Street, New York City. It is of unique



construction, and combines the two most popular features required of present day variable condensers, straight-line calibration and low-loss.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1191.

TERMINAL STRIP

The universal terminal strip shown was submitted to the RADIO

NEWS LABORATORIES for test, by August W. Horing, 3921 Dickens Avenue, Chicago, Ill. It may be used in the construction of any radio receiving set, and has the necessary number of terminals, which are of the Fahnestock clip type, which facilitate quick connection.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1170.

LEMNIS-COIL

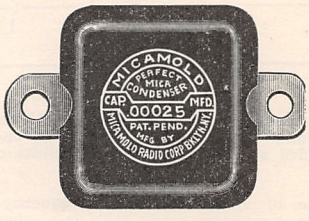
This coil was submitted to the RADIO NEWS LABORATORIES for test by the General Winding Co., 214 Fulton St., New York City. The coil is

wound in the form of a figure eight, giving it a restricted magnetic field and helping to reduce interstage coupling in R.F. amplifiers.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1356.

FIXED CONDENSER

The condenser shown, as well as others of different capacities, was

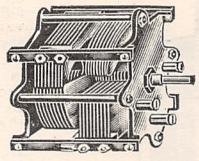


submitted to RADIO NEWS LABORATORIES for test, by Micamold Radio Corp., 1087 Flushing Avenue, Brooklyn, N. Y. Their capacities were found to adhere closely to the values specified for them, and they proved satisfactory in every way.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1115.

TANDEM CONDENSER

The tandem condenser shown was submitted to the RADIO NEWS LABORATORIES for test, by the Allen D. Cardwell Mfg. Corp., 81 Prospect St., Brooklyn, N. Y. It is well built and so constructed that it is entirely fool-proof against future troubles, such as re-alignment, bent plates, loose end bearings, etc. It



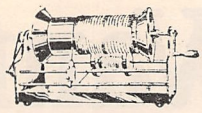
combines all of the popular condenser features such as low-loss, straight-line-frequency calibration, etc.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1208.

COIL-WINDING MACHINE

The winding machine shown in the illustration was furnished by the Wizard Wire Winder Co. and submitted to the RADIO NEWS LABORATORIES for test. This machine is a very handy addition to the radio workshop. Tubing of any size may be wound with any size wire. The guide for the wire travels upon a lead screw which is driven through a belt and pulley by the handle. A wide range of spacing is possible with this machine.

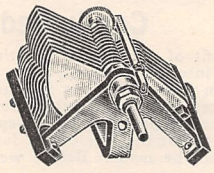
AWARDED THE RADIO NEWS



LABORATORIES CERTIFICATE OF MERIT NO. 954.

S-L-F CONDENSER

The low-loss variable condenser

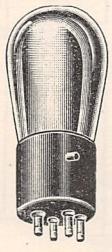


shown was submitted to the RADIO NEWS LABORATORIES for test, by the Goyer Company, Willimantic, Conn. It is made in various sizes and is extremely neat and rugged. It has a straight-line-frequency calibration curve.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1181.

TUBE

The tube shown was submitted to RADIO NEWS LABORATORIES for test, by Star Engineering Co., Arlington,

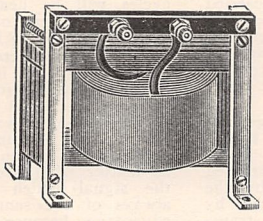


N. J., and found to operate satisfactorily in any radio receiver, either as detector or amplifier.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1187.

FILTER

This apparatus, consisting of a



choke coil and condenser, was submitted to the RADIO NEWS LABORATORIES for test, by C. E. Jacobs, 2802 N. Kedzie Avenue, Chicago,

Ill. The choke and condenser, comprising a low pass band filter, were found to be effective when connected in a B-battery eliminator circuit operating on D.C.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1260.

CRYSTAL

The crystal shown was submitted to the RADIO NEWS LABORATORIES for test by the Mineral Novelty Co., Joplin, Mo. It was found to be very sensitive and may be used in

any crystal receiving set. It is mounted in good form so that it may be easily adapted.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1173.

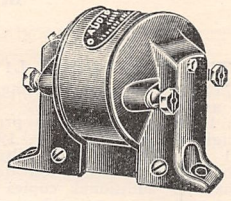
ADAPTOR

The instrument shown was submitted to the RADIO NEWS LABORATORIES for test, by the Alden Mfg. Co., Springfield, Mass. It is a tube adaptor by which the UX-199, 120, etc., tubes may be made to fit the standard VT socket.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1206.

AUDIO TRANSFORMER

This audio transformer was submitted to the RADIO NEWS LABORATORIES for test by Hart & Hegeman, Hartford, Conn. The calibration curves taken for it show that it passed the tests successfully.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO 1202.

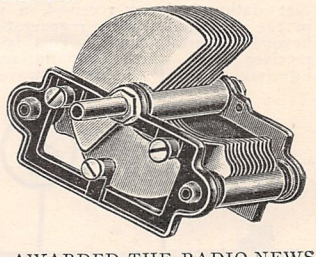
D-COIL

The inductance shown was submitted to the RADIO NEWS LABORATORIES for test by A. F. Henninger Corp., 4509 Ravenswood Avenue, Chicago, Illinois. The construction of this coil is decidedly low-loss, and when connected in a receiving circuit it covers the broadcast range successfully.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1204.

VARIABLE CONDENSER

This variable condenser was submitted to the RADIO NEWS LABORATORIES for test by the Fett & Kimmel Co., Bluffton, Ohio. It is a good condenser of the low-loss, grounded-rotor type and tests showed it to be an exceptionally good instrument.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1098.

INDUCTANCE

This coil was submitted to the

RADIO NEWS LABORATORIES for test by Feri Radio Mfg. Co., 1167 Bedford Avenue, Brooklyn, N. Y. It is of distinctive construction and has provisions for baseboard or panel mounting.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 1189.

Conducted by Joseph Bernsley

THIS Department is conducted for the benefit of our Radio Experimenters. We shall be glad to answer here questions for the benefit of all, but we can publish only such matter as is of sufficient interest to all.

1. This Department cannot answer more than three questions for each correspondent. Please make these questions brief.
2. Only one side of the sheet should be written upon; all matter should be typewritten or else written in ink. No attention paid to penciled matter.
3. Sketches, diagrams, etc., must be on separate sheets. This Department does not answer questions by mail free of charge.
4. Our Editors will be glad to answer any letter, at the rate of 25c for each question. If, however, questions entail considerable research work, intricate calculations, patent research, etc., a special charge will be made. Before we answer such questions, correspondents will be informed as to the price charge.

Mr. Bernsley answers radio questions from WRNY every Thursday at 8:15 P. M.

THE ULTRADYNE L1 RECEIVER

(2171) Mr. J. S. Arlington, Des Moines, Iowa, asks:

Q. 1. I am unable to procure blueprints or the original issue (February, 1924, issue of RADIO NEWS) in which the Ultradyne circuit is described. Your circulation department informed me that no additional copies are available. I, and several of my friends, would like to build this receiver, as we have heard much of its efficiency; in fact, have heard several receivers that incorporate this principle, and I am now determined to build one just like them. Can you please supply me with the necessary data? Undoubtedly you have some copy from which you could obtain the original information. Also, where can I purchase the parts which are most essential?

A. 1. In view of the fact that we have received innumerable requests for Ultradyne data, due to the shortage of back copies in which this information was published, we are herewith reprinting the Ultradyne article. All data are included, for both oscillator and antenna coils and the intermediate transformers; as these parts can no longer be purchased, due to present Super-Heterodyne litigation.

The Ultradyne Receiver, by R. E. Lacault.

(Reprinted from the February, 1924, issue of RADIO NEWS.)

The super-heterodyne receiver is coming more into use among the amateurs and broadcast listeners, on account of its numerous advantages; and it is our intention to describe in this article the construction of a super-heterodyne functioning under a new principle. This improved receiver, which has proved superior to the usual type, is the result of a long series of experiments carried out by the author. The principle of operation of this receiving system has already been explained in many text books and radio magazines; but we shall describe it again in a few words for the benefit of those who do not have such references at hand.

Everyone who has operated an ordinary regenerative receiver has noticed that, when a broadcast station is being received, a whistle is heard in the telephones when regeneration is increased beyond a certain limit. This is caused by the receiver itself, which oscillates and produces, by interference with the carrier-wave of the transmitting station, a beat note of an audible frequency. A beat note has a frequency equal to the difference between the two frequencies which produce it. For instance, if a carrier wave of 1,000 kilocycles is received, a beat note of 1,000 cycles will be heard in the receivers if an alternating current of 999 kilocycles, or 1,001 kilocycles, is made to interfere with the carrier wave.

In the super-heterodyne receiver, this principle is employed; but instead of producing beat notes at an audible frequency, beats of a super-audible frequency, such as 50 or 100 kilocycles are used. By means of a variable condenser the oscillator circuit may be tuned so that such a beat note is produced for any incoming signal. Therefore, no matter what the incoming signal frequency is, the signal which is amplified and detected is always of the same frequency. This is a great advantage, because it is easier to design a radio frequency amplifier to function on one frequency only, than one which amplifies in the same proportion a broad band of frequencies.

In most short-wave radio-frequency amplifiers using untuned transformers, the amplification varies for each frequency. It is generally found that greater amplification is obtained at two points; while comparatively smaller amplification is had over the remainder of the frequency range covered by the transformer. If tuned radio-frequency transformers are employed, the tuning becomes very complicated, owing to the numerous controls; and it is difficult to tune in a station unless the entire amplifier is calibrated. The radio-frequency amplifier used in the super-heterodyne receiver is designed to amplify at maximum intensity at one frequency only; thus increasing the selectivity, since only signal frequencies which are interfered with by means of the oscillator can pass through the amplifier.

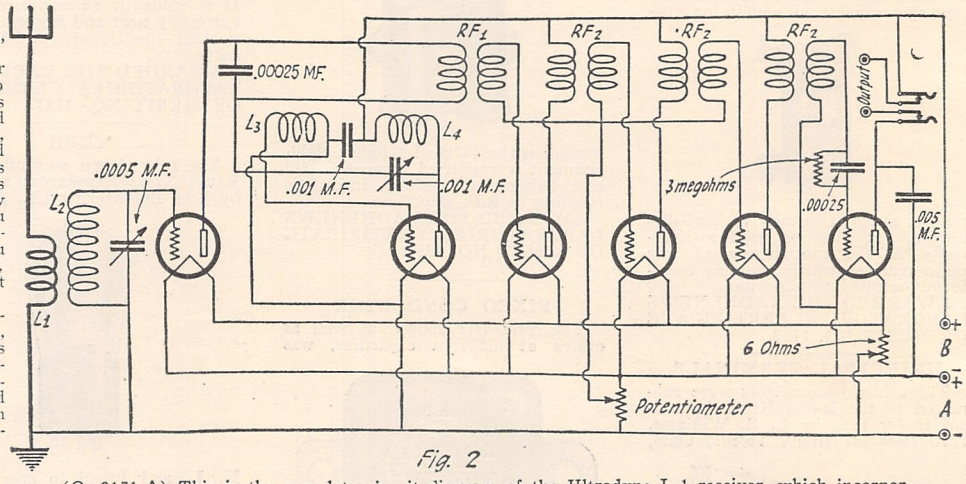
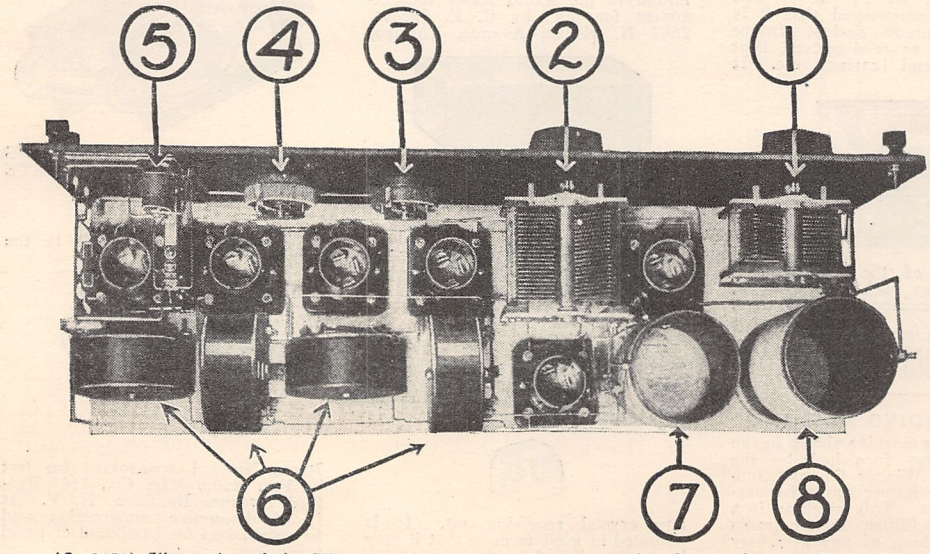


Fig. 2

(Q. 2171-A) This is the complete circuit diagram of the Ultradyne L-1 receiver, which incorporates the "modulation system." As explained in the text, one or two stages of audio frequency amplification should be added so that loud speaker results can be obtained on distant stations.



(Q. 2171) Illustration of the Ultradyne L-1 receiver showing panel and parts layout. Note that the intermediate frequency transformers are mounted at right angles at each other to prevent interstage coupling. A slightly larger panel is required, if audio frequency amplification is to be added to the receiver.

The Modulation System

In the ordinary type of super-heterodyne, the first tube employed as a frequency changer is connected as a detector with a grid-condenser and grid-leak. This detector rectifies the incoming signal after it has been heterodyned, and the variation caused in the plate circuit is amplified through a long wave radio-frequency amplifier. In the system to be described a new principle is made use of. This, which has been called the modulation system, causes the incoming signal to modulate the oscillations produced locally, in the same way that the speech modulates the output of the oscillator tubes in a radio-telephone transmitter. This system, which is a departure from the conventional detector arrangement is not only more simple, but produces a greater signal strength, which is more noticeable on weak signals.

Fig. 1 (Q. 2171) shows the principle of operation of the circuit. The first tube, which is called the modulator, is connected across the oscillating circuit of the oscillator; the plate-filament space acting as a resistance, the value of which is varied by the incoming signals impressed upon the grid. In this arrangement no "B" battery is necessary, for the plate of the modulator tube is supplied by high-frequency current from the oscillating circuit. To receive continuous waves, this arrangement is very efficient, and it has been applied very successfully to the super-heterodyne receiver described in the article.

To give an idea of the sensitiveness of this receiving arrangement we mention the results obtained with it in New York City, the set being installed on the fourth floor of an apartment house situated in a good location. Using only the secondary coil, composed of 72 turns of wire wound

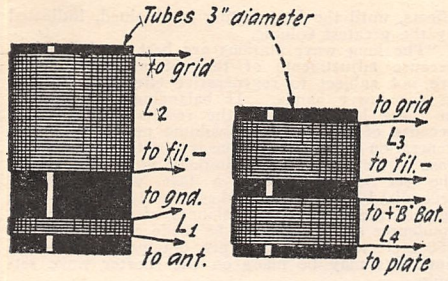


Fig. 6

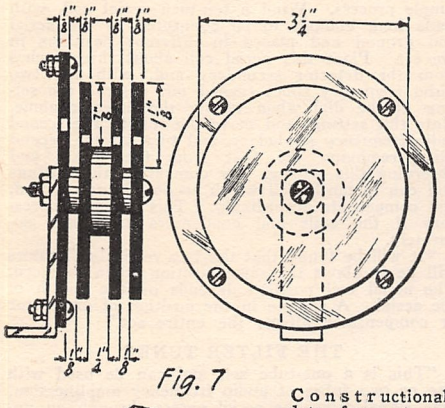


Fig. 7

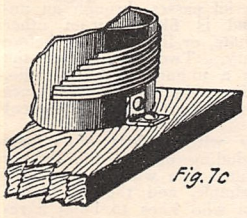


Fig. 7c

Constructional data for antenna and oscillator coils and intermediate frequency transformers. Refer to text for number of turns, etc.

on a tube 3 inches in diameter, stations in Cincinnati, Detroit, Atlanta, Chicago and other cities are heard practically every night with good audibility. **No audio-frequency amplification is used, and no loop, aerial or ground is connected to the receiver.** With one or two stages of audio frequency the loud speaker may be operated and, of course, the music and speech are audible throughout the apartment.

Hook-up and Parts

Fig. 2 is a complete diagram of connections of the receiver. The entire outfit may be mounted in a cabinet 7x24 inches, and is composed of the following parts:

1 Panel 7x24 inches,
1 Cabinet 7x24x7 inches.
1 Variable Condenser .001-μf., with vernier,
1 Variable Condenser, .0005-μf., with or without vernier,
1 Potentiometer,
1 Rheostat, 6-ohm,
1 Double-Circuit Jack,
1 Battery Switch,
7 Binding Posts,
6 Sockets,
4 Radio-Frequency transformers,
1 Grid Condenser, .00025-μf.,
1 Fixed Condenser, .001-μf.,
1 Grid-Leak with mountings,
1 Fixed Condenser, .00025-μf.,
1 Fixed Condenser, .005-μf.,
1 Tube of bakelite, hard rubber or formica, 3 inches in diameter and 6 inches long,
1 tube of the same material, same diameter, 3¾ inches long,
Bus-bar for connections, screws, baseboard 7x23 inches, wire, etc.

The constructional details of the tuning inductance and of the oscillator coil are given in Fig. 6. L1, which is the untuned primary, consists of eight turns of No. 20 D.C.C. wire, wound half an inch from the end of the tubing. L2 which constitutes the secondary, is wound with 72 turns of the same wire, and 1½ inches away from the primary on the same tubing. The oscillator coil is composed of two sections wound in the same direction, as shown in Fig. 6. The first section L3, connected between the grid and the filament of the oscillator tube, is composed of 24 turns of No. 20 D.C.C. wire; while the second section, L4, connected between the plate and "B" battery, is wound with 32 turns of the same wire. These coils should be carefully wound and given a light coat of special varnish, which may be obtained from firms manufacturing insulating materials. If no such varnish is obtainable, a light coat of varnish made of acetone, in which celluloid is dissolved, will do very nicely. No shellac should be used on the coils.

It is advisable to fasten the ends of the wire, in each coil, to small screws with nuts fixed on the tubing, as this permits a good connection to be made between the connecting wires and the inductance. The coils may be fastened to the baseboard supporting them by means of small brackets made of brass strips bent at right-angles as shown in Fig. 7C. The ends of the wire in each coil should be soldered to the screws fastened to the tubing, in order to insure perfect contact. Once the set is wired, a drop of solder should also be applied to the joint of the bus-bar wire and the screw.

R.F. Transformers

The radio-frequency transformers may be of any suitable type designed for long wave reception. Those used in the receiver illustrated are of a special design; and may be easily constructed of hard wood or insulating material, such as hard rubber or bakelite. Fig. 7 shows how these transformers are constructed. They may be turned out of a solid piece, or made up of discs of the proper thickness and diameter. The end disk, which is of greater diameter than the others, supports four screws or binding posts, to which are fastened the ends of the primary and secondary windings; and a bracket, made of a strip of brass fastened under the screw holding the unit, permits its mounting on the base board. The primary should be wound first and should consist of 500 turns of No. 28 double silk covered wire in the center slot, which is ¼-inch wide. The secondary is wound in two sections with No. 30 double silk covered wire: 550 turns should be wound in each slot on each side of the primary. The two sections may be wound without breaking the wire by passing it over the primary from one section to the other. To maintain the ends of the wires in place, a drop of sealing wax may be applied on the last turn of both windings. Once the transformers are wound, the screws used as binding posts are fixed on the large disc and the ends of the wire are soldered to them.

The beginning of the primary and secondary windings should go to the positive pole of the "B" battery and center arm of the potentiometer, respectively; while the outside ends of the windings are connected to the plates and grids of the amplifying tubes. In order to reduce the action of one transformer upon the other, they should be mounted so that their axes are at right-angles to each other. It should be noted that the primary of the first transformer is wound with only 300 turns, so that its natural frequency is brought up to that of the other transformers when the .00025-μf. by-pass condenser is connected across it.

The illustration shows the arrangements of parts on the baseboard supporting the outfit. In order to simplify the wiring of the receiver, it would be advisable to proceed as follows: after the various pieces of apparatus mounted on the panel are fixed, all the wires which are against the panel may be placed and soldered. The sockets, inductances, and transformers are then wired separately and the panel fixed to the base. The only connections which remain to be made are those joining the condensers, rheostat, potentiometer and binding posts.

Before mounting the various parts on the panel and baseboard, it is a good precaution to screw tightly all the screws and bolts of the sockets, rheostats and other apparatus, which are very difficult to reach with tools, once they are fixed on the panel or board. We strongly recommend that any amateur attempting to build such a receiver, use instruments of good quality, as this is an important factor in the results obtained with a super-heterodyne receiver of this type. The connections should be made with bus-bar wire bent at right-angles, or else with No. 16 copper wire, which is cheaper and very efficient for connections.

Aerial and Ground

If a loop aerial is used, the tuning inductance composed of L1 and L2 is not necessary, since the loop is connected across the first condenser in place of the inductance L2. However, it is preferable to use a short antenna; as the signal strength is greatly increased with this type of collector. If no antenna can be installed outdoors, a single wire, stretched around a room at a distance of about a foot from the walls and ceiling by means of insulators, will be preferable to a loop. The ground connection may be taken on the radiator system, the water pipe, or any other grounded metal-work. If none is available, a counterpoise may be made with a length of lamp cord wound spiral-fashion under the carpet, or rug.

The tuning of the super-heterodyne receiver is extremely simple, and in a short time anyone should be able to bring in distant stations, provided the tuning and oscillator condensers are turned very slowly. As the tuning is very sharp, a vernier is necessary on the oscillator condenser, but it may be dispensed with on the tuning condenser, which is not so critical in adjustment. The receiver may be calibrated if the same loop or tuning circuit is used at all times; and if desired a silver dial may be employed on the tuning condenser, thus permitting the inscription of the station call letters to be put directly on it.

To tune the receiver, the tuning condenser should be moved two degrees at a time, and the oscillator condenser turned over the whole scale range for each setting of the tuning condenser. Some station should be heard at one place or another along the scale; if whistles are heard, the potentiometer controlling the radio frequency amplifier should be turned until the whistles stop. The station may then be brought in loudly and clearly. The potentiometer may then be adjusted at the most critical point, where amplification is maximum; and need not be readjusted unless very weak signals are tuned in. The rheostat acts as a vernier for the potentiometer, and sometimes may prove quite useful in bringing to good audibility a distant station. It will be found that signals are heard at two different adjustments of the oscillator condenser; it is best to try the setting which gives loudest signals. After a few hours spent in operating this receiver, it will be quite easy to tune in stations, for at a certain point a slight rushing noise is heard, indicating that a carrier wave is tuned in.

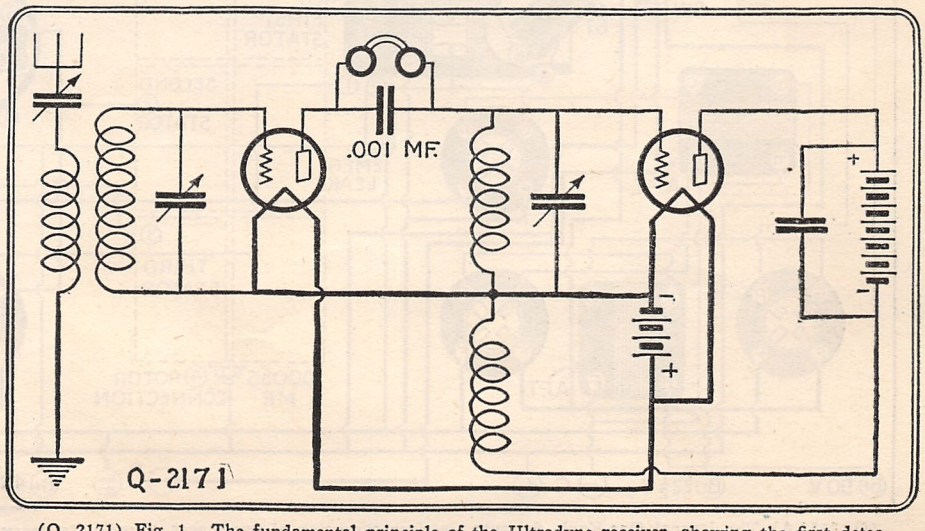
From 45 to 90 volts of "B" battery may be used on this receiver. If an audio frequency amplifier is added to operate the loud speaker, it is advisable to use a separate "B" battery on the audio frequency tubes, although the same filament battery may be used. It is recommended to use 201-A or 301-A tubes for the modulator and radio frequency amplifier. A different tube may be used as a detector, although very good results may be obtained with one of the above-mentioned tubes, if the proper grid-leak resistance is used. For the oscillator we would recommend a 216-A, or E tube (VT-2), although any other tube which operates well as an oscillator may be employed. It is a good idea to try the tubes in different positions, for very often some tubes function better in some stages than in others.

NEW YORK EVENING JOURNAL CIRCUITS

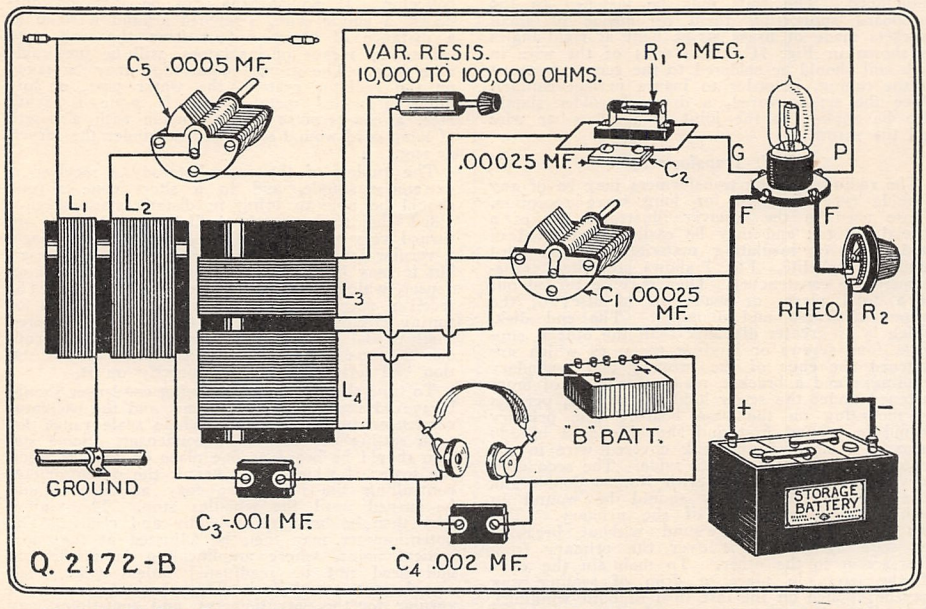
(2172) Mr. R. Contini, Brooklyn, N. Y., asks:

Q. 1. Can you furnish me with the circuit diagram of the Journal's new One-Knob set, and all other data necessary for the proper construction of this receiver, as I am unable to obtain the radio section of the New York Journal in which this receiver was published? Please do not give the schematic circuit diagram, as I am unable, as yet, to understand radio symbols. A diagram of the picture type, that is, showing a picture of the various instruments used and the wiring connected to the various instruments in the proper order, will be greatly appreciated. Also, may the coils be purchased? I would rather buy them than attempt to construct them (due to lack of radio experience), unless absolutely necessary.

A. 1. We are herewith showing a set diagram of the new Journal One-Knob receiver, as you request. Also, due to the enormous popularity of



(Q. 2171) Fig. 1. The fundamental principle of the Ultradyne receiver, showing the first detector and oscillator circuit employing the efficient modulation system. This method is a radical departure from the conventional, and results in a receiver of remarkable efficiency.



(Q. 2172-B) The Journal One-Knob Filter Tuner, is an efficient one-tube receiver which is very popular with New York fans. A consistent DX-getter, and yet easily operated. Either the dry-cell or storage-battery type tube may be employed, with practically equal efficiency.

this and other circuits published by the New York Evening Journal, and the numerous requests received for this and the other circuits, we are publishing the entire group, including all the data necessary for the construction of each. The circuits are named as follows:

Journal One-Knob Circuit, Journal Selective Filter Tuner, and the Journal One-Tube One-Knob Set. (The last will appear in next month's issue.)

The following is the list of parts necessary for the construction of the Journal One-Knob set (5-tubes):

1 Panel 7x21x3-16 inches,
1 Baseboard 10x19 inches. This size is necessary because of the triple-gang condenser, room for which must be provided,
1 Single-Circuit Jack,
1 Battery Switch,
1 Triple or three-gang Condenser of three .00035 μf. units, all of which are rotated by a single shaft,
1 Grid Leak, 2-megohm,
1 Grid Condenser, .00025-μf.,
9 Binding posts, etc.,

The coils are wound with a half-pound of No. 22 D.C.C. copper wire on bakelite tubes three inches in diameter. The first tube, the aerial coupler, is 3 inches long; the other two each 3½ inches long. Three rotor coils are 2¾ inches in diameter and ¾-inch long. We know of no commercial manufacturer who is producing these coils. It is possible to obtain coils somewhat similar in construction and rewind to make them coincide.

Adjustments

The following is a description, taken from the New York Journal, of the proper method of adjusting the receiver.

"The process of balancing the Journal's new one-knob set is done somewhat in this manner: tune in a long wave station around 500 meters, more or less, for a preliminary test to determine if the condenser sections need to be balanced. Take a ruler without a metal edge or a wooden stick, not a pencil, and turn the rotor of one coil and then another, beginning with the aerial, one way or another to hear which position gives the loudest signal.

"When this is found turn the condenser to another station lower in the wave-scale, and make another adjustment of the coil rotors. If a gain in signal strength is observed it indicates that the condenser sections are not balanced; and if no gain occurs it shows that the sections need no further attention.

"If the condenser sections are balanced properly, they will show an equal reduction in capacity as the shaft is turned toward the lower wave-scale; and when this is so the coils will be tuned alike on the high and low waves. If one section of the triple condenser reduces in unequal amount, one coil will be out of tune, which will be shown when the rotor, being turned, will increase the volume at any point.

To Change Capacity

"Each section of the condenser is provided with a means of increasing or decreasing the capacity, to compensate for any differences that exist between one section of the condenser and another. To balance the condenser, tune in a long-wave station again, and move the compensating plate on each section, using a stick to avoid hand-capacity effects, until the best setting is obtained, indicated by the greatest volume.

"The long wave stations are best for balancing, because adjustments of the set at these points are not subject to regenerative effects that occur in the lower bands. If balancing is attempted in these low channels, the results will be false because of the increased volume produced by regeneration when the balance is upset. Here is one case where the strongest impulse is obtained when the set is unbalanced, a fact which will be recognized when one makes the test. For this reason, the preliminary balances of both coils and condenser sections should be made on waves above 450 meters. After they are obtained, further refinements may be made on the shorter wave settings.

"If you suspect that one section is badly out of tune with another, it can be tested by a simple process. Wind a ten-turn aerial coil, with leads long enough to be connected to the aerial and ground and placed in different positions in the set. Place this aerial coil about three inches from the detector secondary and, with the two radio frequency tubes turned off, observe the setting of the dial when tuning the detector alone. Note this setting, and move the coil to the second radio frequency secondary, and turn on the second tube, removing the first from the socket and observing this setting. By comparing the settings you can instantly tell which section is unbalanced, and compensate accordingly. This is never necessary if the coils and condensers are made accurately.

"It will be found that the two vertical-coil rotors will be in about the same position when balanced. The aerial coil position depends on the length of the aerial. A change in the position of any rotor or compensator affects the entire set."

THE FILTER TUNER

"This is a one-tube set, and can be used with one or two tubes of audio frequency amplification. The signal from the aerial passes through an untuned primary coil and is filtered from other signals by two intermediate, or linking coils, before it reaches the secondary. Two features of the Filter Tuner, giving it a unique place in radio, are the arrangements for reducing the resistance of the linking circuit and for controlling the current used for the purpose.

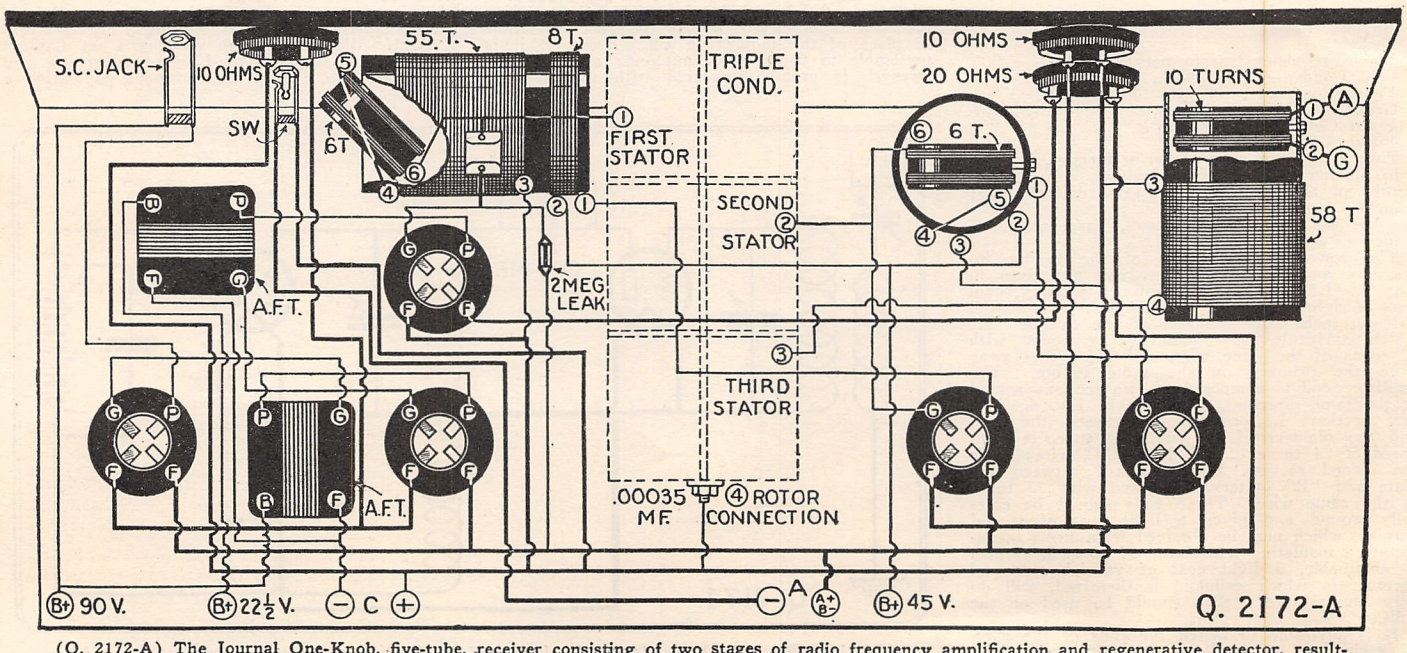
"Increased selectivity without loss of volume is accomplished by including one of the linking coils in the plate circuit. The wiring, as shown in Fig. Q.-2172B, is simple, and the set is appreciated by the person who likes to build a receiver at home. Regardless of the theoretical complexity of the circuit, it can be made and operated by the novice.

"Standard parts are used, which may be obtained at the cost of an ordinary one-tube set. The coils are wound on two bakelite or cardboard tubes, three inches in diameter. The tube for the primary and first filter coil is four inches long; and that for the second filter coil and secondary winding is six inches long. No. 20 D.C.C. copper wire is used on the four coils.

"Both filter coils, L2 and L3, have forty turns each, while the primary L1 has twenty-five, and the secondary L4 sixty turns. As shown in the arrangement of the parts, the tubes are mounted at right-angles, to eliminate inductive transfer of energy from the primary to the secondary direct. This excludes all but the desired station.

"The variable-resistance unit controls the strength of the magnetic field produced by the second filter coil L3 which, in turn, affects the

(*Continued on page* 1605)



(Q. 2172-A) The Journal One-Knob, five-tube, receiver consisting of two stages of radio frequency amplification and regenerative detector, resulting in an extremely efficient and selective receiver, although only one dial is employed for tuning. Any type of tubes may be employed in this receiver, although for best results it is advisable that storage-battery type, 201-A or 301-A tubes be used throughout.

Radiotron UX-199 the same tube but with the new standard base.

Radiotron UV-199 dry cell tube for both detection and amplification.

Low in cost to run

IT'S the special filament of an RCA Radiotron UV-199 (or UX-199) that makes it cost so little to run. This tube draws so little current that for a limited time it can even be operated from flashlight batteries—for your portable sets! It never needs more than inexpensive dry batteries—and it uses them up slowly.

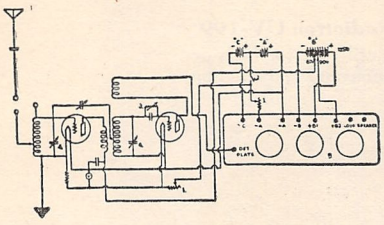
The thoriated filament of this tube is specially treated, so that there is always a layer of thorium a single atom deep on the filament-surface. And electrons leap from the thorium at a stupendous rate—conveying the music and the speech.

Because this type of filament gives off more electrons at less heat—it lasts longer, and it uses less battery current. And because this type of filament was developed in the great research laboratories that contribute to RCA, you will find it in every genuine RCA Radiotron UV-199 and UX-199. Another good reason for being careful to find the RCA mark on the base when you buy!

RADIO CORPORATION OF AMERICA
New York Chicago San Francisco

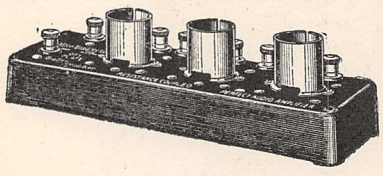
RCA Radiotron

MADE BY THE MAKERS OF RADIOLAS



Improve the Browning-Drake *with a* Bradley-Amplifier

Resistance-Coupled PERFECT AUDIO AMPLIFIER



THE Bradley-Amplifier is a ready-built, ready-to-install audio-amplifier. It contains no transformers, but is equipped with Bradleyunit resistors which *amplify without distortion.*

The quality of the Browning-Drake receiver, like any other selective radio set, can be improved by substituting the Bradley-Amplifier for audio-frequency transformers. Try the Bradley-Amplifier with the Browning-Drake receiver and be assured of amplification without distortion.

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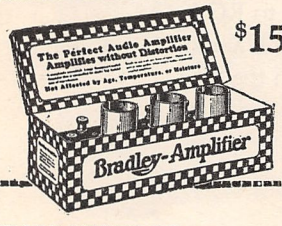

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How Radio Tubes Are Evacuated

(*Continued from page* 1551)

tain conveniences of use. They are, however, so expensive and difficult to keep in first-class working order that they are of little practical use to amateur experimenters. We have already spoken of the way in which gas molecules fly about at average speeds of many miles per second, and over average paths which are longer as the pressure becomes lower. A molecule of air travels, at a pressure of 1.0-mm., on the average .01-mm. before colliding with another molecule—whereas at a pressure of .01-mm. it travels one entire millimeter without collision. Similarly at a pressure of .001-mm. it travels freely, on the average, ten millimeters and so on. When these molecules strike a stationary wall they bounce off, just as a base ball would from a brick wall. Different molecules coming up from different angles all bounce off in their appropriate directions; so that the motion of the reflected molecules is quite as haphazard as that of the incident ones. If however the surface struck is moving sideways at a high speed a drift in the direction of motion will be imposed on all molecules reflected from the wall and a stream of gas will be thus established in the line of motion of the wall. This is the principle of the molecular pump.

Fig. 3 illustrates this notion. The drum D is rotating in the direction of the arrow at a high speed, say 12,000 R.P.M. The gas molecules coming in at A strike on this drum and a flow is set up toward the opening B through which the reflected molecules finally escape. In order that this action may

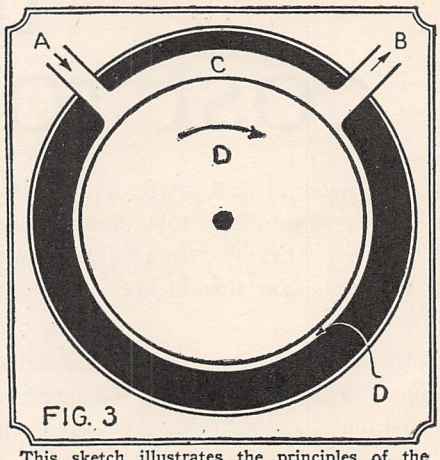


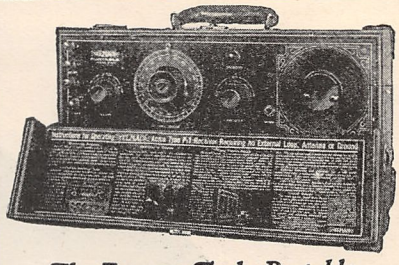
FIG. 3

This sketch illustrates the principles of the Holweck rotary pump. There is a molecular flow from A to B caused by the speed of the rotating drum, D, about 12,000 R.P.M.

go on it is necessary that the pressure in the space C be so low that the average travel of the molecules is completely across from the outer wall to the drum. It is also necessary that the crack around from B to A through D should be so narrow that few molecules work through it and thus escape evacuation. Pumps operating on this principle consequently require an excellent fore-pump—one producing .001-mm. pressure, such a rotating Gaede pump; and also the closest possible machining between drum and case. These requirements render such pumps expensive.

THE HOLWECK PUMP

Although the first molecular pump was made by Gaede the best pattern available today is that of Holweck. The rotating drum of the Holweck pump is a cylinder, smooth on the outside, driven by an induction motor which is inside the pump casing. The vessel being evacuated is attached to the tube at the top, R (Fig. 4) and the molecules travel along spiral grooves cut in the



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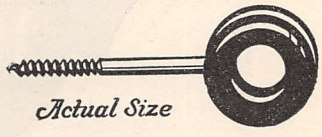

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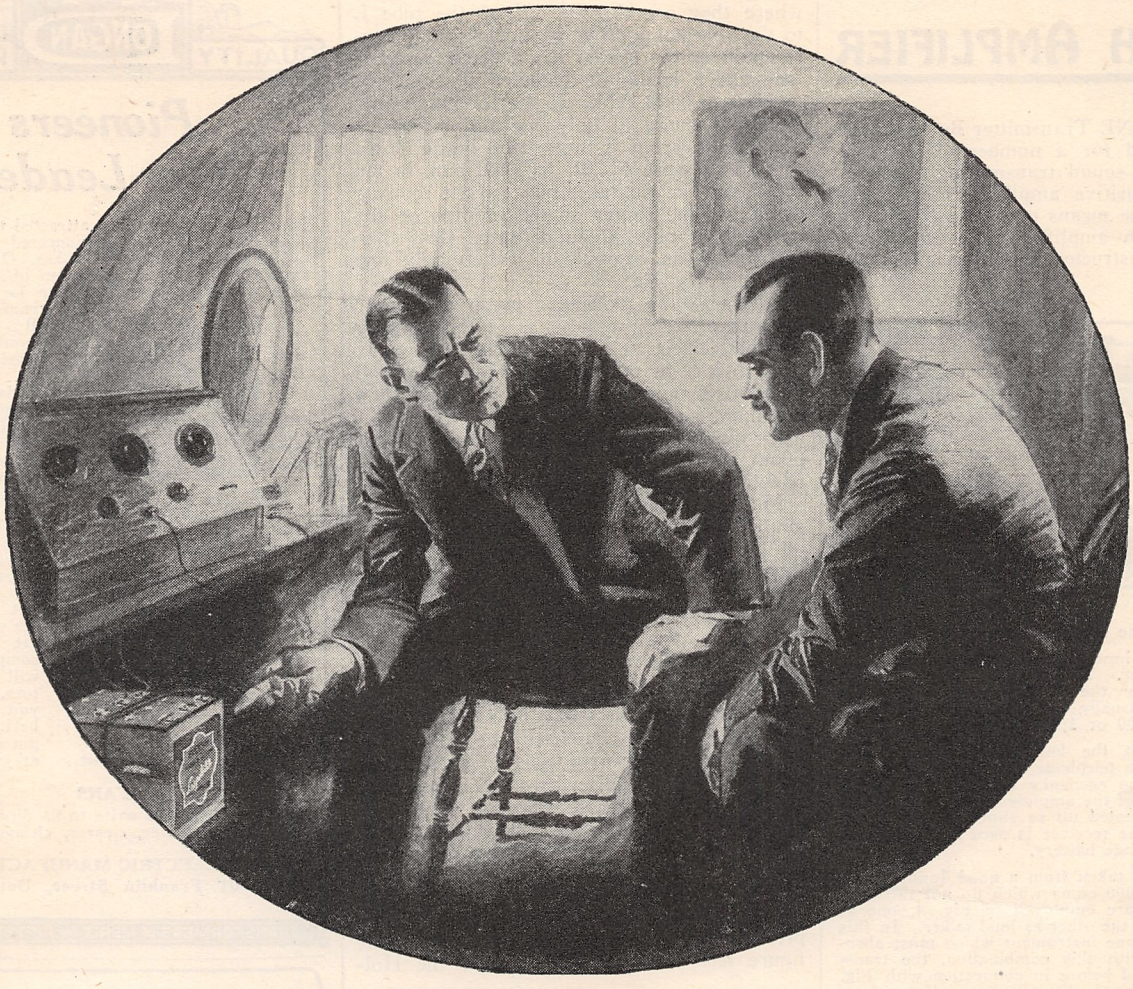

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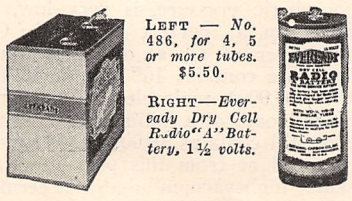

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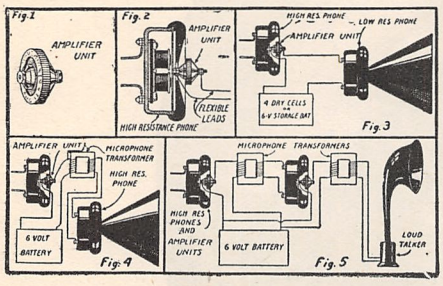

Fig. 1 shows the amplifier unit.

Fig. 2, shows how the unit is attached to a telephone receiver. The first procedure is to mount the unit on the diaphragm of a telephone receiver, which usually is a high resistance telephone, either 1,000 or 1,500 ohms.

Next we select the loud speaking telephone. If a low resistance telephone is available, it should have for maximum efficiency an impedance equal to the resistance of the amplifier unit, or about 10 ohms; it is connected up as shown in Figure 3. A 5 ohm telephone receiver is used in this circuit with a 6-volt storage battery.

Two telephones taken from a good double headset of 2,000 to 3,000 ohms which do not rattle on strong currents, are employed in Fig. 4, one at the receiving end, the other as loud talker. In this hook-up there is one instrument which must absolutely be used with this combination, the transformer. As stated before in connection with Fig. 3, the impedance of the telephone, if used in direct connection, should equal the resistance of the unit. But as the impedance of the telephone in Fig. 4 is much higher than the resistance of the unit, it may be 200 times as great, a transformer having a step-up ratio is used to match up the resistance of the unit with the impedance of the loud speaking telephone. In other words, the primary coil of the transformer should have an impedance (which is sometimes called "A. C. resistance") equal to the resistance of the unit, or about 10 ohms, and the secondary coil should have an impedance equal to the impedance of the high resistance telephone. This transformer may be purchased in any Radio Store and is called a microphone transformer or modulation transformer, designed primarily to use in radio transmitting sets. A 6-volt battery gives the best results. The current passing through the unit will vary from .1 to .25 ampere.

Fig. 5 shows a circuit for further increasing the volume of sound. This is simply two of the circuits, such as shown in Fig. 4, linked together. This arrangement is highly sensitive and the telephones on which the units are mounted should be packed in a box of cotton, as the slightest vibration or sound in the room will be picked up and heard in the loud talker. Any sensitive radio loud talker may be used in this particular circuit.

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casing from the two ends toward the center where they are thrown out of the tube L to the forepump. The particular pump represented in the sketch has a drum 8 inches long and 6 inches in diameter which is rotated at 4,000 R.P.M. If the forepump produces a vacuum of only one millimeter this pump will bring a five-quart bottle down from a pressure of .01- to .0001-mm. in ten seconds. The clearance between the rotating drum and the ridges of the grooves on the envelope is only about .02-mm. (less than .001-inch)—an example of exceedingly fine mechanical work.

Although the molecular pump can never produce a zero pressure, as is theoretically possible for the mercury condensation pump, nevertheless, in practice, the Holweck pump gives a vacuum as good as or better than the mercury pump, and seems to give it more quickly. In other words the Holweck pump is apparently the fastest and most effective air pump yet produced.

Molecular pumps possess a particular advantage over other types in that molecules of all gases and vapors alike are hurried out through the exhaust. Water and mercury vapor are thus eliminated without the use of freezing mixtures or other accessories. This is a very important feature in some investigational work and is in all cases a great convenience.

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We have now completed the description of the various types of vacuum pumps used in laboratories and elsewhere. We have been talking of "the most effective pump yet produced." Let us notice briefly just how close these "most effective pumps" actually come to producing a "perfect vacuum." Some experimenters working with mercury condensation pumps claim to have obtained pressures as low as .0000001-mm. A similar figure has also been claimed for the Holweck pump. Critical judges are however inclined to think that in all probability the lowest pressure reached up to this time is about a millionth of a millimeter. This pressure, which is one one-billionth of normal atmospheric pressure, is very low, yet it is far from a "perfect vacuum." One cubic centimeter of air at ordinary atmospheric pressure contains 10^{19} (about 10,000,000,000,000,000,000) molecules. At a pressure of a millionth of a millimeter, one cubic centimeter still contains 10,000,000,000 molecules. Looked at from this point of view, the famous "high vacuum" does not seem so very high. There is, however, another point of view. The average path over which a molecule travels without colliding with another is, at a pressure of .000001-mm., about 250 feet. It is evident therefore that in a small receptacle evacuated to this degree the individual molecules will act, each one, very much as if entirely alone so that for many applications the space may be thought of as "practically empty."

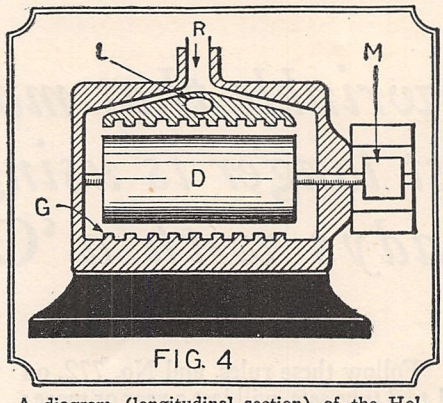

FIG. 4

A diagram (longitudinal section) of the Holweck rotary pump. M is the induction motor, and G, the spiral grooves in the casing, which is less than 1/1000 of an inch from the drum, D.

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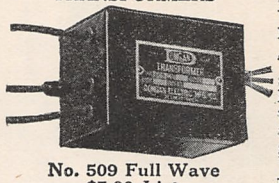

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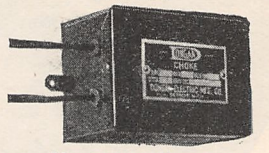

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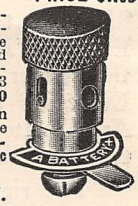

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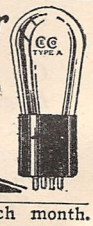

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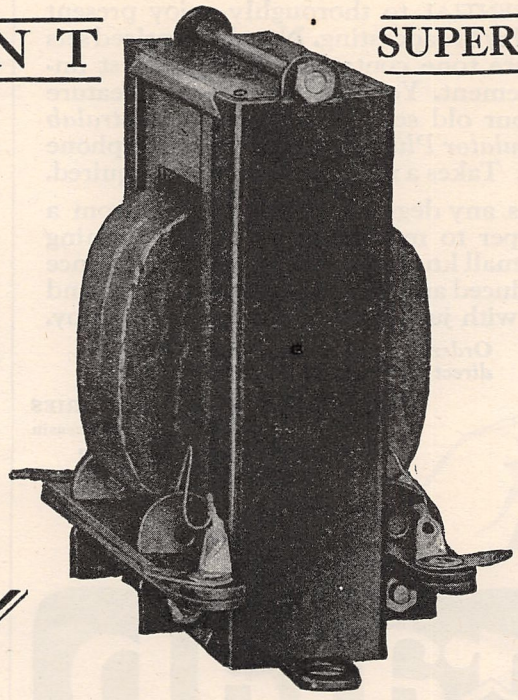

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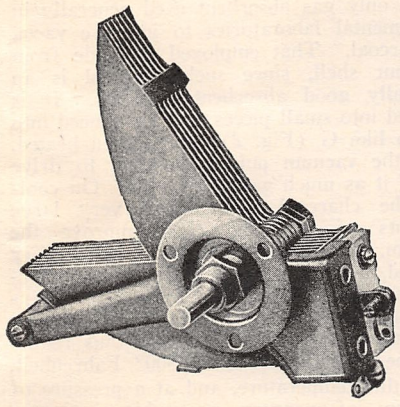

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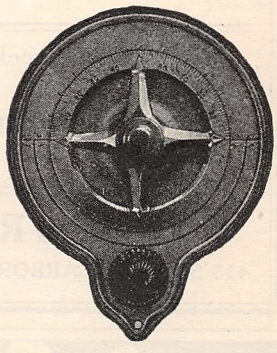

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Earlier in this article it was stated that a radio tube ought to be heated and held on the vacuum pump at least one hour, in order to obtain dependable results. It goes without saying that no such lengthy treatment is given in the commercial preparation of tubes or of incandescent lamps. A maximum time of evacuation under heating in practice is a quarter of an hour; incandescent lamps are rarely evacuated at a high temperature for more than five minutes and frequently for one minute or less. It is evident that such tubes at the time they are cut loose from the pumps cannot have a vacuum better than .001-mm., and must frequently contain pressures up to 0.1-mm. These pressures are reduced to the average operating pressure of perhaps .00001-mm. by burning out in a test rack, either with or without the aid of certain chemicals introduced into the bulb. Phosphorus, arsenic, sulphur, iodine and their compounds, and powdered metallic thorium and zirconium have all been used in this work. These materials are frequently referred to as "getters." They are introduced into the tubes prior to evacuation and take up the excess gas the first time the lamp is lighted.

The mere burning of a new tungsten filament lamp on the test rack causes the pressure to drop from .001-mm. to .00001-mm. in a half hour, due to a little-understood reaction between the gas ionized in the tube and the material of the filament. The gas is "occluded" or "covered up" largely, apparently, on the walls of the bulb. A similar effect is brought about through use of the "getters," but less time is required, ninety per cent. or more of the gas being removed by the getters in about one minute. These getters leave deposits of characteristic colors on the tubes in which they are used. The shiny, yellowish or brownish coloration of radio tubes is due to this cause. A great deal of study has been put on "getters" in commercial laboratories, since an effective compound of this sort has a high financial value in reducing the expense of tube manufacture. The use of such substances, however, demands a complicated procedure which make them of little value to the amateur experimenter.

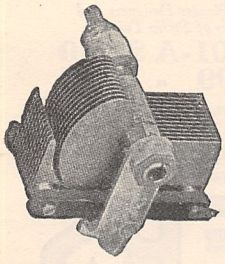
The only gas absorbent used generally in experimental laboratories to improve vacua is charcoal. That employed is made from cocoanut shell, since such charcoal is an especially good absorbent for gas. It is cracked into small pieces and introduced into a trap like G (Fig. 2). It is then heated, with the vacuum pumps running, to drive out of it as much gas as possible. On cooling the charcoal will absorb very large amounts of gas and thus improve the vacuum. The effect is, however, not so very marked, unless the temperature of the charcoal is reduced far below normal. The general practice is to surround the trap containing the charcoal with liquid air thus reducing the temperature to — 300° Fahrenheit.

At this temperature, and at a pressure of .001-mm. of mercury, one cubic centimeter of charcoal will absorb about 900,000 cubic centimeters of nitrogen measured under the same pressure. Under these conditions the use of charcoal makes an enormous improvement in the vacuum. In fact, by the use of charcoal and liquid air, a first-class vacuum, around .000001-mm., can be produced with relatively inferior pumps.

This information is, however, of little value to amateur workers since liquid air can be purchased only in the large cities, and even there not without difficulty. The amateur who wishes to evacuate radio bulbs is probably best advised to rig up a Sprengel pump of the pattern described in Part I of this article (pages 1282, 1356, March RADIO NEWS). This pump, used with a salt and ice freezing mixture, will give slow but reliable results at very small expense and little trouble.

SM

Dependable



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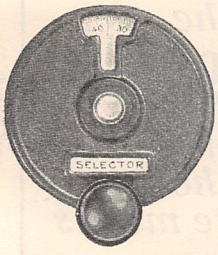

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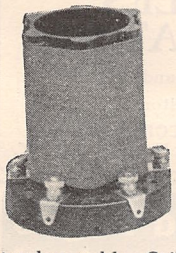

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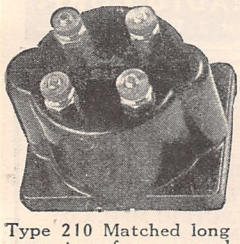

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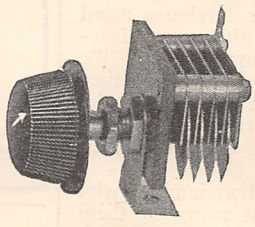

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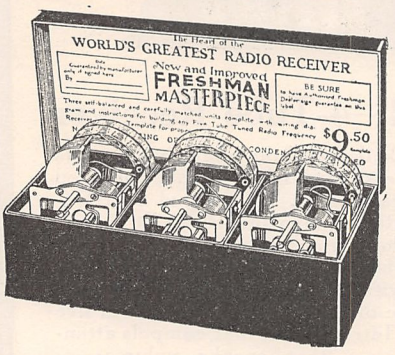

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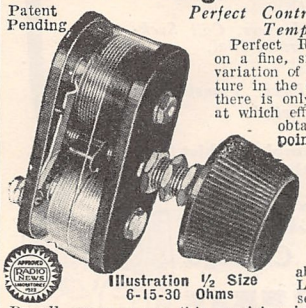

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Radio Makes Servants Contented

(*Continued from page* 1523)

in terms of her personal happiness and amusement. We may not like to do it; we may hate to have to give our time and money to this subject; but our homes are important to us, and we greatly need good personal service in them. Therefore, we must make some further sacrifices of time and money to have this service.

To permit your servant to take piano lessons on your time, is, I admit, going a little far. But she should not be denied music, for it is one of the greatest solaces in life. *Why not let servants have access to radio?* I have thought about this situation quite a bit and have come to the conclusion that radio has a deeper relationship to the modern servant problem than is generally understood. There are great numbers of well-to-do families, with homes in the suburbs or the country, who have a particularly difficult problem in keeping servants. They do not like to have them go a long distance away in the evenings, for fear they may not come back again in time for their duties; and for many such, situated a mile or two away from the average amusement for servants, this is a very important question. *I know radio has solved this problem for me.* I have a home in the country, and have proved that radio definitely makes life more agreeable and their jobs more endurable for my servants. The higher the mental calibre of servants, the more necessary it is that they have a higher grade of entertainment than in days gone by. I have found that, since I have had a separate radio set installed in the servants' wing, in preference to going out to a movie they stay in and listen to the radio.

MAKES WORK MORE EFFICIENT

The young eighteen-year-old girl I had for upstairs work was particularly lively; and if jazz music was to be had over the radio while she was sweeping, she put twice the effort into her work and cleaned twice as efficiently! These are not idle statements. They are facts. At first it rather amused me to notice it, but then I realized that it "pepped" her up, and also that it made work more pleasant. She did not develop so many grouches, or longings to "go somewhere."

In the kitchen, where the cook spends most of her day, without anyone to talk to all day (for the proverbial cop on the beat and his ultimate liason with the cook is but a worn-out hand-me-down from other days), I found that it was making life thoroughly worthwhile to her; and from a grim-visaged elderly person, she was becoming quite rejuvenated and happy-spirited.

A SMOOTHER OF TEMPERS

After years of observation, I am convinced that servants who work alone and live in the house and don't get much chance to go out and have normal social life, music or entertainment, invariably develop a mood which ends in quarreling with you and leaving. They may not know what is the matter with them, and they may say they don't want to go out; but unless they do, or have an outlet such as radio gives them, they will develop moods and permanent grouches.

There are about one million families who have servants, and a great many of these servants get surprisingly little contact with the outside world. Between four walls daily; long exhausting hours of work; very little social conversation—no wonder they are so delighted at what the radio can give them; music, education, lectures, amusement, and above all, contact with the world! This is indeed the crying need of all women—whether they be housewives, or servants!

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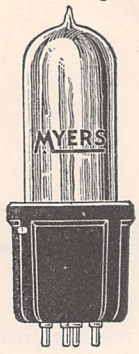

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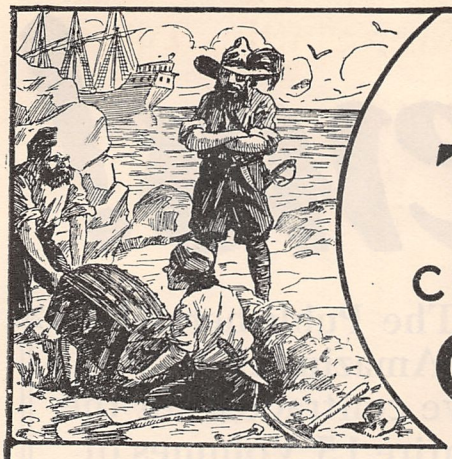

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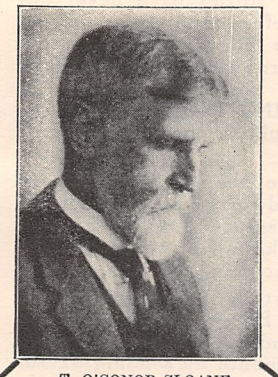

T. O'CONOR SLOANE, A.B., A.M., LL.D., Ph.D.
Noted Instructor, Lecturer and Author. Formerly Treasurer American Chemical Society and a practical chemist with many well known achievements to his credit. Not only has Dr. Sloane taught chemistry for years but he was for many years, engaged in commercial chemistry work.

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What Some of Our Students Say of This Course:

I have not written since I received the big set. I can still say that it far exceeded my anticipations. Since I have been studying with your school I have been appointed chemist for the Scranton Coal Co. testing all the coal and ash by proximate analysis. The lessons are helping me wonderfully, and the interesting way in which they are written makes me wait patiently for each lesson.—MORLAIS COUZENS.

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So far I've been more than pleased with your course and am still doing nicely. I hope to be your honor graduate this year.—J. M. NORKUS, JR.

I find your course excellent and your instruction, truthfully, the clearest and best assembled I have ever taken, and yours is the fifth one I've studied.—JAMES J. KELLY.

From the time I was having Chemistry it has never been thus explained to me as it is now. I am recommending you highly to my friends, and urging them to become members of such an organization.—CHARLES BENJAMIN.

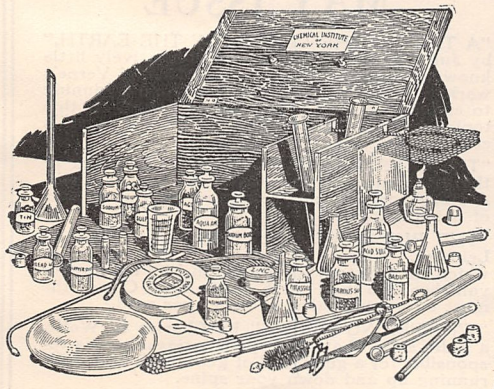
I shall always recommend your school to my friends and let them know how simple your lessons are.—C. J. AMDAHL.

I am more than pleased. You dig right in from the start. I am going to get somewhere with this course. I am so glad that I found you.—A. A. CAMERON.

I use your lessons constantly as I find it more thorough than most text books I can secure.—WM. H. TIBBS.

Thanking you for your lessons, which I find not only clear and concise, but wonderfully interesting. I am—ROBT. H. TRAYLOR.

I received employment in the Consolidated Gas. Co. I appreciate very much the good service of the school when a recommendation was asked for.—JOS. DECKER.



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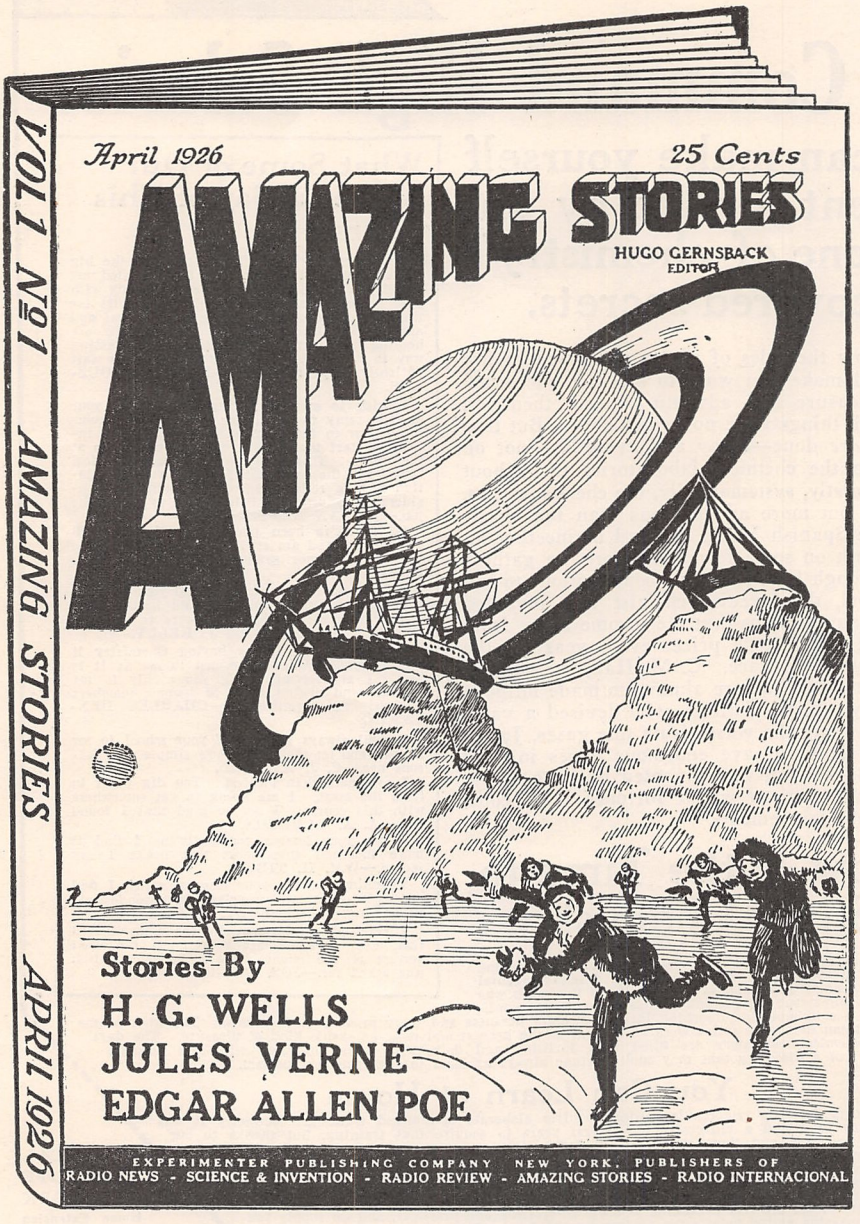
Great News!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The Radio Burglar

(*Continued from page* 1531)

mind being bossed awhile by the younger generation. When you get the hang of it all perhaps we'll be partners in the enterprise. Radio's a great business. It's going to revolutionize society. Did you ever hear a concert from WGY?"

"Never heard a concert from anywhere. Never saw a radio. What're they like?"

"You'll see plenty of 'em in the store. If it's all the same with you, I'll put you to work installing sets. The fellow who is doing it for me now doesn't know anything. It shouldn't take you long to learn more than he knows about it, and it's interesting work."

The old-fashioned burglar grunted: "What's this surprise of yours?" he wanted to know next.

"You'll see it on the way home," said Kenneth, laughing uneasily.

They left the train at Bronx Park West and walked for several blocks. Then Kenneth steered into a small apartment house.

"Thought you said you lived over a store," the old-fashioned burglar remarked.

"We do," Kenneth replied, "I'm just going to show you the surprise."

On the third floor Kenneth rang a bell. The door was opened by a slim and unbelievably pretty girl, who lifted her face for a kiss. Kenneth supplied the want with an air of propriety.

"Peggy," he said, "I want you to meet my dad. He just arrived. Dad, this is your future daughter-in-law."

Father-in-law to be gulped in surprise, shook hands, and then thrust his hand foolishly into his pocket, where it came in contact with a few crumpled bills, all that were left of the ten dollars that he was given, together with his ill fitting suit and black hat, when the warden bid him good bye and good luck. One thought flashed into his mind—wedding present! And he had no money, to speak of.

"We're to be married the day after tomorrow," Kenneth explained. "That's why I told you to keep that date open. We need congratulations."

The congratulations were tendered in the old-fashioned burglar's rather shaky voice. They spent an hour with Peggy's family. Then, the good-nights over, the father and son walked another block, and paused below an electric sign that read DOYLE RADIO COMPANY in letters composed of bits of lightning flashes.

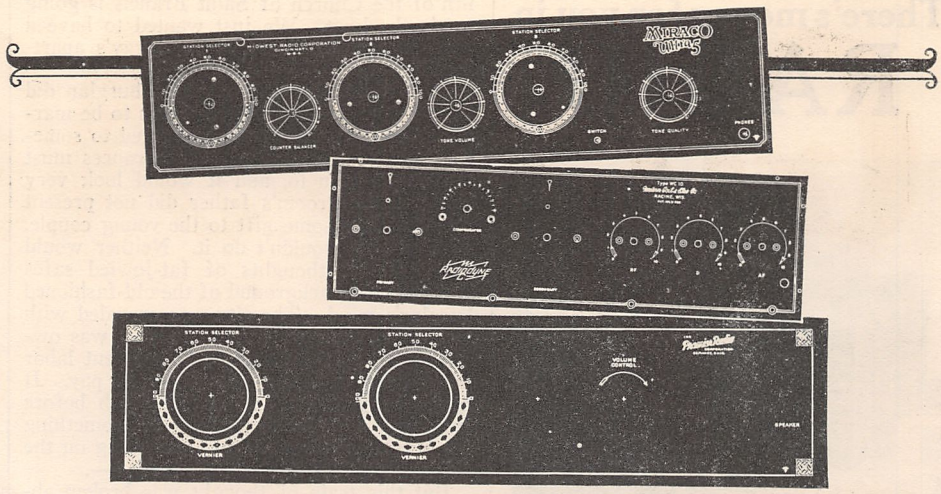
"Here we are," announced Kenneth. "I guess there's no use going in tonight to look the store over. You must be pretty tired from your trip. We get upstairs through this side door."

On the way up the old-fashioned burglar was introduced to Sparky Peters, one of Kenneth's two employees. As they parted, Sparky called up the stairs, "Oh, Ken, I wonder if you could handle a service slip on Vandenberg's Radiola, tomorrow night? He was in today, but I couldn't leave the store while you were away. He says he'll drop around at eight-thirty with his car, and drive you back. Just wants new "Bs" installed. Won't touch the set himself. He doesn't know an ohm from a rectifier. Can you make it?"

"O. K." agreed Kenneth, without any particular enthusiasm. Vandenberg was a good customer who must be pampered, as he was thinking of installing radio loud speakers in every room of a hotel that he owned. Kenneth wanted the contract. But the night before his wedding was an awkward time to do the pampering.

"When's the wedding going to be, son? I mean, what time of day?" asked the old-fashioned burglar.

"At four in the afternoon. Father Grif-



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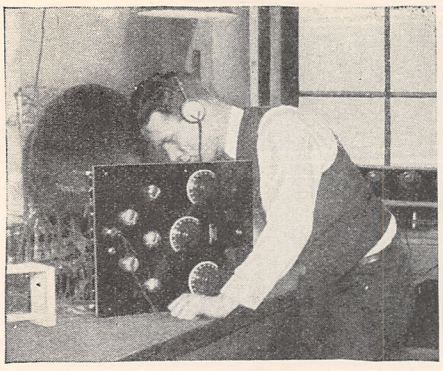

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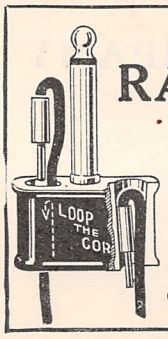

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fith of the Church of Saint Francis is going to tie the knot. We just wanted to have a few friends, so it's to be in Peggy's apartment."

That night the old-fashioned burglar did not sleep well. His only son was to be married, and his total wealth amounted to something under five dollars. Appearances must always be seen to, and it would look very badly if the groom's father did not present the most handsome gift to the young couple. Five dollars wouldn't do it. Neither would fifty. Vague thoughts of fat-jowled safes floated in the background of the old-fashioned burglar's mind. The city was crowded with wealth, and undoubtedly some of it was owing to him for the amount of efficient labor he had put in at the prison, for no pay. It might be well to "do" one last job before swearing off. That would give something for a wedding present, and something on the side with which to start life anew——.

But this train of thought was broken abruptly by the memory of his decision to go straight. If he were captured cracking a safe immediately after getting out of prison on the same offense, there would be no chance for an alibi, and no reason to expect leniency. Finally he fell asleep.

The old-fashioned burglar woke with a determination in his mind. He must get a job, and draw advanced salary. It was the only way out. The hounds of pride bayed furiously in him, at the thought of begging or of borrowing money from Kenneth for the purpose of giving him his own present. Noiselessly he pulled on his clothes and slipped away without awakening his boy. He noticed as he passed the store that the sun shade was down to hide the contents of the window. As yet he had never seen a radio set.

The old-fashioned burglar's search took him downtown by easy stages. But times had changed again. It was not as easy to get a job as it had been in nineteen-five or -ten. And besides, employers asked about the last job, and were not at all enthusiastic about adding to their forces a man who had just been discharged from a hospital, after a long illness, the marks of which were only too noticeable in the pallid face of the ex-invalid.

At noon he was tired of the search, and by afternoon thoroughly discouraged. He came back at dusk without even a job, to say nothing of an advance draft on his mythical salary. Within half a block of the store he paused to look at his watch. Seven-thirty, and dusk setting in. Again the thoughts of squat, well-fed safes crowded into his mind. Why not? His skill had been uncanny, in the old days. He had never used tools—nothing but the magic of his sensitive fingertips. Perhaps it would be best to do one last job after all, just to spite the police, if for no other reason. But there were other reasons aplenty.——.

Swiftly he made his decision, wheeled, and walked rapidly westward for a few blocks until he came to an avenue of apartment houses. He followed this northward in the gathering darkness, until his eye chanced to wander down a side street full of residential buildings, some of them palatial.

The old-fashioned burglar sauntered down the side street in apparent unconcern, but with his old keen eyes doing triple duty. Most of the houses were lighted, and he discounted these. Two that he passed were deserted, with shutters closed and fastened, and the lower entrances boarded. He discounted these also. There was no time for such a job.

But finally, near the next corner, he came upon a house with a grey stone front that contrasted with the brownstone of the rest of the street. It was set back a bit, and had a stone veranda with ornamental pillars. And there were no lights. The house was

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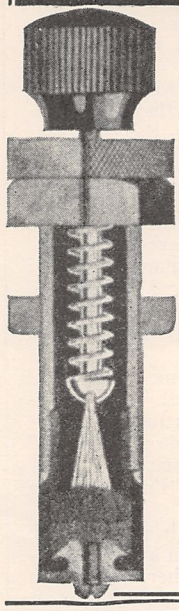

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quite evidently occupied, as the ash barrels and garbage cans in the cellarway were full. The old-fashioned burglar glanced about him, casually. No-one was in sight. Quickly he was in the cellar areaway, hidden in the recess of a door. The door was locked, but the lock was of the old-fashioned type, perfectly understandable to the old-fashioned burglar. He took out his pen knife, which contained, as well as two blades, the now indispensable corkscrew. The end of this he quickly straightened out under his heel, then bent into a half hook. A half minute of probing with this improvised implement located and moved the tumblers of the lock, and the door was open.

Inside could be seen a passage stretching darkly into nothingness. The old-fashioned burglar shut the door behind him and felt his way cautiously for a few feet, tracing the wall, until it brought him back to his starting place. All the other doors had been shut. It was safe to strike a match. Cautiously he tried the other three doors. The first was a laundry, the second a staircase, and the third evidently a recreation room for the servants.

Cautiously he returned and ascended the stairs. Very cautiously he slipped through kitchen and pantry into the main hall. A quick survey of all of the rooms downstairs showed that no one was in them. Evidently it was "night out" for the servants.

The old-fashioned burglar knew that house safes are usually located in the library, behind a false panel of books. So he returned and began a slow inspection of the bookshelves, tapping as he made his way in the darkness. Finally the tapping produced a hollow sound. He struck a match to investigate, but found nothing more than a row of hollow letter files. He was about to blow out the match when his eye caught, in the corner, the outline of a safe, entirely exposed. As the match went out, he glanced at his watch. It was after eight-thirty. Another match showed the safe to be an ornamental one, in a Tudor cabinet.

The old-fashioned burglar mumbled something about new-fashioned contraptions as he shook out the light and crossed the room. He felt for the dial, but when his hand touched it it felt peculiar, and light. But the old-fashioned burglar was not surprised at anything, any more. He commenced to twirl it. There was no clicking as there should be in a respectable safe. The whole thing was ridiculously light. The old-fashioned burglar stopped, perplexed. He moved his hand slightly, and felt another dial.

"The first one must be a fake," he chuckled. "But that's a thin kind of trick to use to fool anyone but a complete chump."

The new dial, when turned slowly, gave forth a clicking sound, ever so faint, more felt than heard. This was better. The old-fashioned burglar gave it half a turn. As he did so, a light appeared magically somewhere within the safe. A burglar alarm! As he started back in fright, a voice spoke in a hollow, sepulchral way. "This is WEAF, broadcasting the concert given by the ————:"

Yet there was no one to be seen in the half-light that came from the little openings in the safe. Half unconsciously, half in bravado, the old-fashioned burglar stepped to a stand lamp and flashed it on. Then he approached the curious safe once more. There seemed to be no danger. But he was unaware that the mysterious voice had drowned out the opening of the front door. And as he knelt in perplexity before the strange safe, the door of the library was pushed open by Mr. Vandenberg, owner of the house.

"What the devil——," he began, but Kenneth, who followed him in with an armload of "B" batteries, interrupted. He had taken in the situation at a glance.

"Say, pop, you chump," he said, "this isn't

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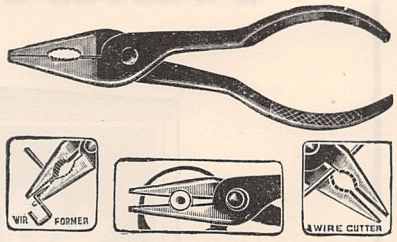

COMBINATION PLIER

Combination Plier, Wire Cutter, Wire Former and Wrench. Drop forged, slender but exceptionally strong. 6 inches long.
No. 202—Combination Plier, Wire Cutter, Wire Former and Wrench.....75c

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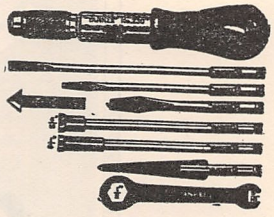
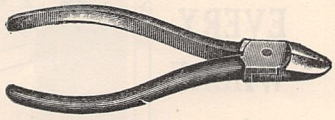


RADIO TOOL SET

This is the handiest set of tools ever made for Radio Work by the makers of the famous "YANKEE" Tools. It contains the following: 1 Ratchet Screw-driver, 6½ in. long holding all attachments; 1 Blade, 5½ x 3-16; 1 Blade, 3½ x ⅛; 1 Blade 2½ x ¼; 1 Countersink; 2 Socket Wrenches for all small nuts; 1 Reamer to enlarge holes in panel from ⅛ to ½; 1 Wrench, one end 5-16" square or hex. for jack, other ½" hex., etc.
PRICE per set—No. 701.....$3.00

NO. 201



SIDE CUTTING NIPPER, LAP JOINT

For cutting all kinds of wire. Jaws hardened and oil tempered. Natural steel finish with polished jaws. Length 6 inches.
PRICE—No. 201 .....75c

CIRCLE CUTTER

Especially designed for the Radio Constructor. Made of the finest material and equipped with the highest grade high steel cutting bits. It does three things at once. It drills its own pilot, cuts out plug and puts bead or scroll around the hole in one operation. Cuts holes ¾ to 4 in. in diam.
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401. Same tool but smaller and not fitted with bead or scroll in one operation.
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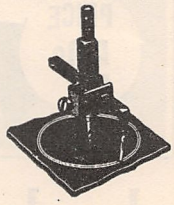

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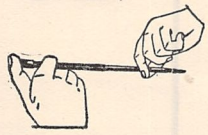

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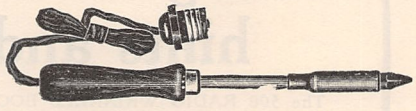

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A perfect tool for Radio Work. Operates either on 110-volt A.C. or D.C. The heat element is of Nichrome, which prevents overheating and assures the desired even temperature. Size of Iron, 10½ in. long. A 4-ft. cord and plug is furnished.
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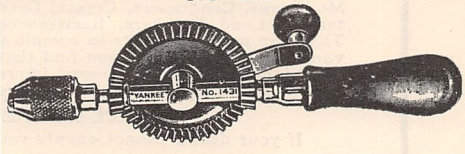

HAND DRILL

Especially designed for Radio Work by the makers of the famous "Yankee" Tools. A beautiful balanced, small, powerful drill with 4 to 1 ratio of gears for speed. Special chuck 9-32" capacity, to take largest drill, mostly furnished with drill or tool sets. Length over all, 9½ in. Weight 1½ lbs.
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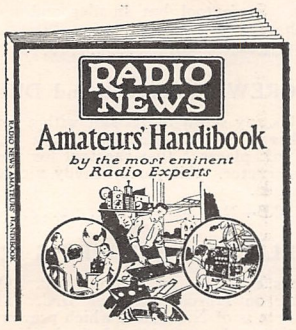

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your job. I told you to take the first service slip. The one on the lower hook. You're supposed to be up on Morningside avenue. All this set needs is a change of batteries."

"Is this one of your men?" queried Vandenberg sharply.

"Yes, he picked the wrong service slip."

"How'd he get in here? There's nobody home."

But the old-fashioned burglar had caught his cue.

"Through the cellar door," he answered glibly. "There was a note on the slip that no one would be home, but that the cellar door would be left open."

"But the door here wasn't open," countered Vandenberg.

"Look and see for yourself," answered the old-fashioned burglar amiably.

So Mr. Vandenberg spent a satisfactory minute cursing the carelessness of the servants.

The old-fashioned burglar looked on with growing awe and irritation as his son plunged into the innards of the thing he had thought was a safe, and substituted new batteries for the old ones. "Well," he said finally, "That's the first one of those damned contraptions I ever set eyes on."

Mr. Vandenberg wheeled suspiciously, and Kenneth glared at the old-fashioned burglar, inwardly cursing him, but saying aloud "That little joke of yours has lost its edge, pop. People used to think it was funny, but you've played it to death."

Mr. Vandenberg, his suspicions annulled, drove them back to the store. The old-fashioned burglar spent an uncomfortable five minutes with his son, and eventually made his confession.

"But I'm going straighter than an arrow from now on," he announced. "This world has advanced too far for an old-fashioned burglar!"

Building the Roberts Circuit

(*Continued from page* 1563)

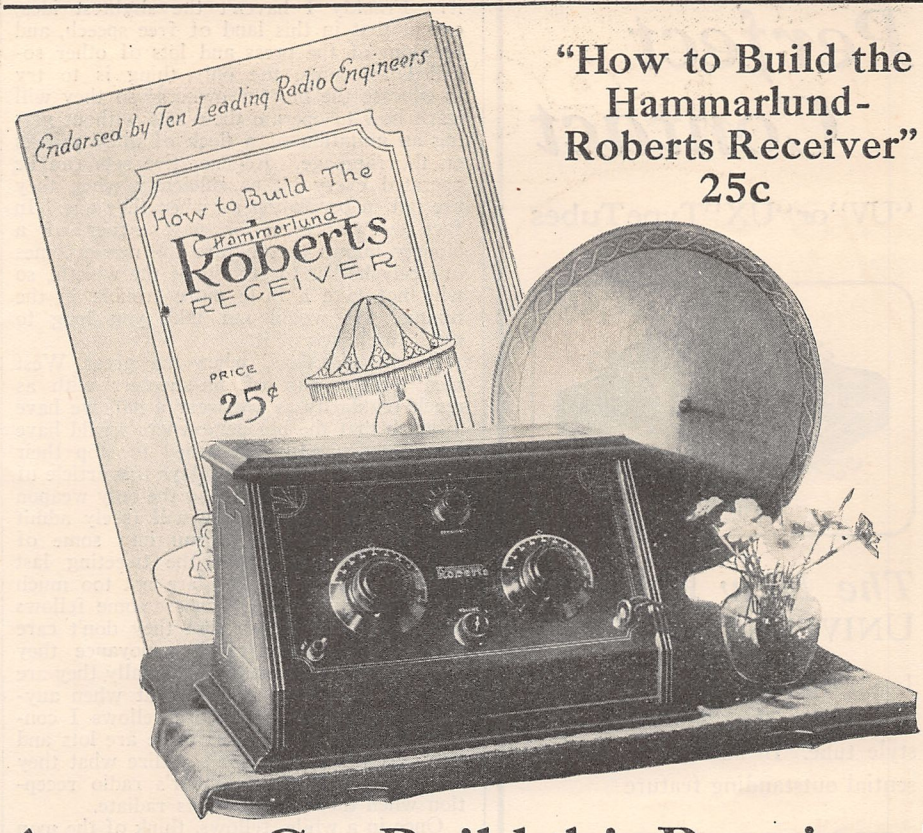
1 "midget" variable condenser, 5-plate, 16-$\mu\mu$f.,
1 set Roberts coils,
2 4-inch dials,
5 vacuum tube sockets,
1 1¾-inch dial,
1 25-ohm rheostat,
1 single-circuit jack,
1 battery switch,
1 metallized resistor,
4 amperites, No. 1-A,
1 .00025-μf. grid condenser,
1 .002-μf. fixed condenser,
1 .006-μf. fixed condenser,
5 prs. phone-tip jacks,
1 Roberts foundation unit, as supplied by manufacturer.

"Try and Get 'Em!"

(*Continued from page* 1527)

these United States there is no law to tell you what sets or circuits you can not use; but, O Brothers in Radio, we sure do need something to kill off some of the hounds that use—or rather misuse—bloopers. I admit the old feed-back is a corking good circuit, and I used to own and operate one; but I never had a neighbor bawl me out for letting her oscillate. And DON'T you think for a minute that they would hesitate to do it either. I knew them all and we were great radio friends.

To my way of thinking it is a downright shame that the tests with Europe had to be completely spoiled, just because a lot of thoughtless fellows filled the air with



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Simplicity of design and ease of assembly are notable features of the Hammarlund-Roberts Receiver. Thousands have built it. Hundreds of testimonials from actual users pay tribute to its remarkable performance in volume, distance, selectivity and tone quality.

You can build the Hammarlund-Roberts from the simple, non-technical instructions in this book. You will have a laboratory designed receiver equal to any factory-built set and at half the price. Designed by ten of the country's leading engineers and backed by these leading manufacturers:

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Carter Radio Co.
International Resistance Co., ("Durham Resistors")
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Send for this book, giving full instructions on wiring, assembling and operating the Hammarlund-Roberts Receiver. Price 25 cents. Below are some of the products used in the famous Hammarlund-Roberts.

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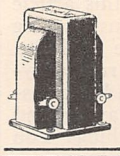

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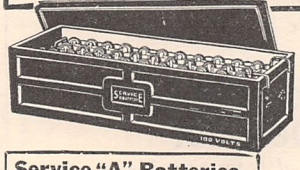

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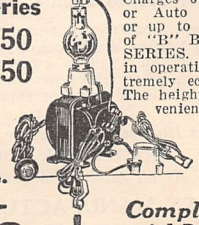

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howls and yowls. What can be done about it? Frankly I haven't the slightest idea, except that in this land of free speech, and freedom of the press and lots of other so-called freedoms, the only thing is to try to educate the blooper owners; so they will learn how to operate their sets without giving an imitation of a flock of alley rabbits on the rampage. Regenerative sets can be operated every bit as efficiently when they are not in oscillation as when they are. In fact every present or past owner of a blooper knows that before the music comes in nicely he has to get rid of the whistle, so why not take a little more trouble in the tuning? It would not take you long to catch the knack of it.

In the old days, when the great West men wore a pair of six-shooters with as much regularity as we wear a hat, we have a hunch that the blooper owners would have been very speedily persuaded to stop their howling. Of course nowadays this article of dress has been discarded, so the only weapon is a pair of fists; but we will freely admit that we would like to run into some of those birds who caused the tweeting last January—that is, if they are not too much bigger than we are. Of course some fellows are so all-fired selfish that they don't care one little bit how much annoyance they cause other people—and incidentally they are the first ones to let out a blat when anyone annoys *them*—and those fellows I consider hopeless. However, there are lots and lots of fellows, who don't realize what they are doing to their neighbor's radio reception when they let their sets radiate.

Once in a while, fellows, think of the man next door or in the next block, for your set may broadcast to an unwilling audience for quite a distance. Let these International Tests be a lesson to you. Don't let the blooper oscillate; and next year, let's have a real silent night when Europe broadcasts to us, not only from our broadcast stations but from the listeners as well.

The Etiquette of Radio Transmission

(*Continued from page* 1573)

is found that will entirely eliminate the ripple. We have indicated 2-μf., as that is the value of the condenser that we have seen used several times successfully; but we have also seen just half that value do wonders for the modulation of a station.

We hope the fellows to whom this article is directed will heed the suggestions that we want to put across. For the love of Mike, fellows, think of the man who is really trying to do some serious work with his transmitter. Is it fair to him to play around with your outfit and jam up everything? You know how the fur would fly, if anyone stepped on your toes the way you are jumping on his—so let's have a little reciprocity. Follow some of the suggestions that are set forth in this plea, and let's leave the jamming to Mother; she has had more practice at it than we have.

The New B-6 Donle Detector

(*Continued from page* 1549)

the coil of the buzzer wavemeter and the coil connected to the detector tube being investigated.

ADJUSTMENT OF "B" VOLTAGE

The sensitivity of this tube is affected to a considerable degree by the value of plate potential used and it is highly desirable in all cases, in order to secure the best results,

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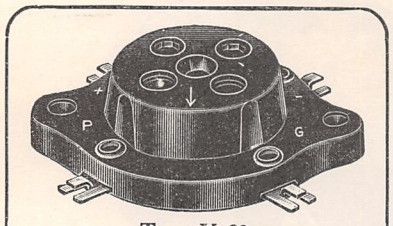

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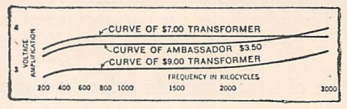
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that this be carefully adjusted. The method whereby this adjustment can be made most readily, and which simplifies to a certain extent the receiving circuit, is shown in Fig. 6. A rheostat with a high resistance

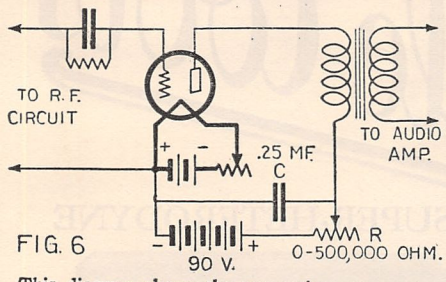


FIG. 6

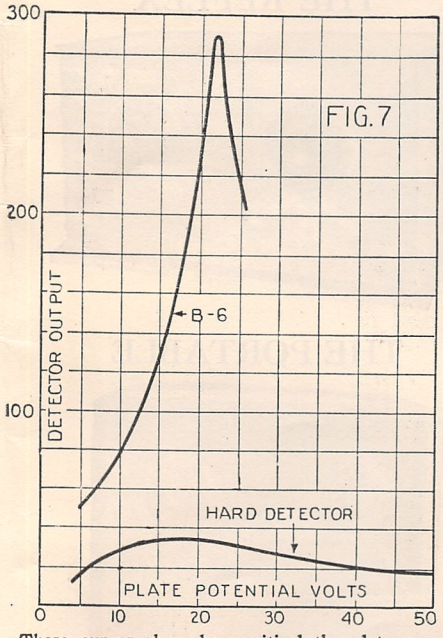
This diagram shows the connections necessary for obtaining the correct plate voltage.

range is connected in series with the plate circuit of the detector tube and is shunted by a fixed condenser and connected to the 90-volt terminal of the "B" battery instead of the usual 22½ volts. This rheostat is adjusted until a signal of maximum volume and quality is obtained and, will not require further readjustment at any time.

The results obtained by the use of this adjustment are shown in Fig. 7, which is a curve showing the output of detector with a fixed value of applied signals for various values of plate potential. On this same curve is also shown, taken under similar conditions, the performance of a typical "hard" detector. While these curves show that reasonably good results can be secured with the new detector without this adjustment, still there is in practice a substantial gain by its use, particularly as these new detectors vary somewhat in this characteristic.

REBALANCING SOMETIMES DESIRABLE

When this detector is used in any circuit where one or more stages of radio frequency precede it, the gain due to the more sensitive detector is modified to a greater or less extent by the effect of the detector-input-circuit impedance upon the balance of radio frequency circuits. In other words, a circuit, which has been balanced for a "hard" detector tube having a certain value of input impedance, may not be in proper balance



These curves show how critical the plate potential is for the Donle tube, and the opposite for a hard detector.

when this new detector is used. Fortunately the difference in the value of this impedance is not sufficiently great to cause any material embarrassment; but it is desirable, if the means are available, to rebalance the

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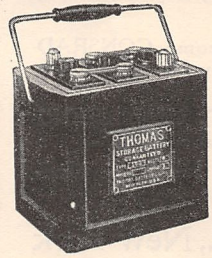

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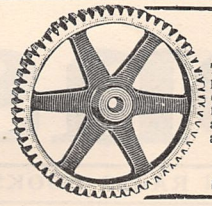

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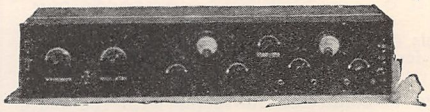

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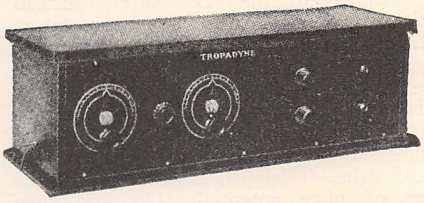

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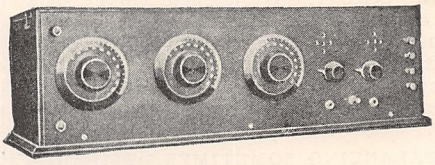

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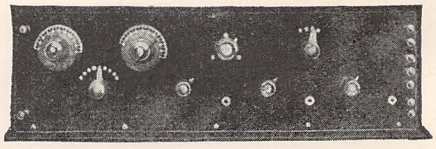
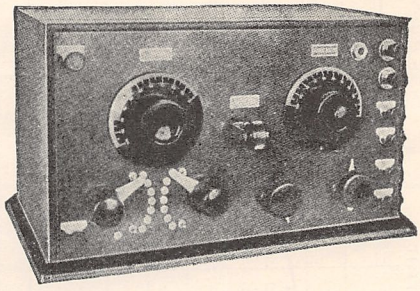


THE REFLEX



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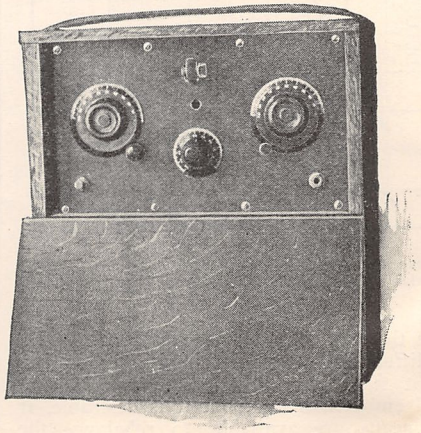

radio frequency circuit with the new detector in operation. On a neutrodyne circuit, for example, this can be accomplished quite readily; but in some other types it is rather difficult to rebalance and, therefore, the gain secured by the use of this tube will not be equal to what it should be under most favorable conditions, although it is decidedly worth while.

This tube is most particularly adapted to a receiving circuit where no regeneration in the detector is employed. A circuit particularly designed for the new detector, incorporating all the desirable features which allow the maximum operation from the detector to be secured is shown in Fig. 8. It is extremely sensitive, gives excellent signal quality and volume and, furthermore, is simple to construct and operate. Various other forms of circuits are being designed for use with this detector, which depend largely upon sensitive detection for their operation, rather than upon the addition of many stages of radio and audio amplification; thus eliminating multiplicity of tubes, noisy operation and distorted signals, common to the usual radio set.

"B" Batteries, Chargers and Eliminators

(*Continued from page* 1533)

are pushed away in a corner, out of sight, and more often than not are covered with dust and dirt. This condition should not be tolerated. Keep the surface of the batteries perfectly clean and free from dust and particularly from moisture. This should be most carefully watched between the terminals, because moisture or dust at this point will present a path whereby current can leak from one pole to the other and slowly discharge the battery.

In the case of dry "B" batteries, keep a constant check on the voltage so that, when the voltage of 22½-volt units falls to 17 or 18, you can purchase a new set and keep it at hand until the batteries that are in use fail to function properly. With storage batteries also keep a constant check on the voltage with a standard battery voltmeter, such as is obtainable at any radio store; and when the value falls to below 90 per cent. of the normal voltage, place the storage battery on charge overnight. In this way, it will always be ready for use.

"B" BATTERY ELIMINATORS

As mentioned before in this article, alternating current cannot be used for charging storage batteries; and of course it cannot be employed directly for operating vacuum tubes, or as the "B" potential. To attempt to do so would result in a tremendous hum in the reproducing unit which would render all reception impossible. However, by placing suitable instruments between the A.C. line and the radio receiving set, the alternating current can be so changed in character that the current delivered from the eliminator will take the place of "B" batteries and give perfect satisfaction. Three different types of "B" eliminators are illustrated in Figs. 7, 8 and 9. The first type, Fig. 7, employs a principle similar to that of the battery charger shown in Fig. 6. By means of an electrolytic action, as the action taking place in a rectifier of this nature is called, the current is changed from "alternating" to "pulsating direct"; and by means of a suitable filter system of proper design, the pulsating direct current is so smoothed out that it resembles that delivered by batteries. It can then be applied directly to the receiving set and hooked up in exactly the same way as "B" batteries.

The invention of a new type of vacuum tube has recently been announced, making possible another type of "B" battery elimina-

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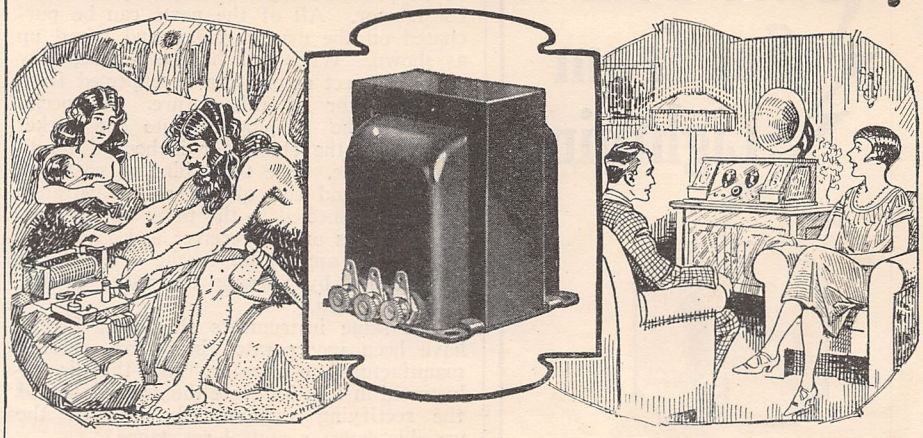

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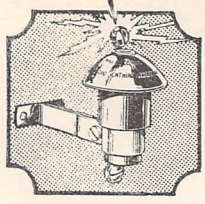

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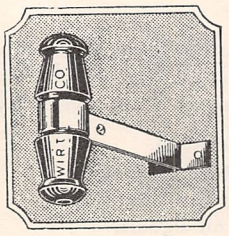

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tor which is very nearly perfect in action. The units shown in Figs. 8 and 9 use this new tube, and the one shown in Fig. 8 is of a type that can be assembled by the home constructor. All of the parts can be purchased on the market today and wired up as shown. When this has been done, very nearly perfect results can be expected from an eliminator of this nature. A special vacuum tube is plugged into the socket shown and the eliminator is hooked up to the A.C. line. The three binding posts, on the right-hand end of the unit illustrated, are then connected to the three "B" battery binding posts on the receiver and a variable voltage for application to the detector can be obtained by varying the value of the rheostat shown.

The same instruments shown in Fig. 8 have been incorporated in a commercially manufactured eliminator, and this is illustrated in Fig. 9. Note the accessibility of the rectifying vacuum tube and of the variable detector-control resistance.

What Is Regeneration?

(*Continued from page* 1565)

sistance (300 meters) for the average receiving aerial is about 15 ohms, and the value of C_a is about 300 $\mu\mu f$. It is common practice to refer to a radiation resistance of "fifteen ohms," meaning, of course, the effective *series* resistance as shown in Fig. 8.

In view of the physical position of the antenna, and with consideration of how electro-magnetic waves are radiated, it seems more logical to the writer to place the true radiation resistance in *shunt* with the condenser as shown in Fig. 9. If the above average figures, of 15 ohms series resistance, 300 $\mu\mu f$. capacity and 300 meters, be used; it may be shown that Fig. 8 is equivalent to Fig. 9, if the true radiation resistance R_r in Fig. 9 is made equal to about 18,700 ohms. The surprising thing about this calculation is that the equivalent plate-filament resistance of an electron tube as ordinarily used will be about 20,000 ohms. The damping of the average antenna and average tube will be almost the same!

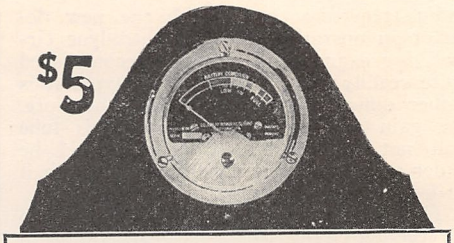
Now if we can consider the voltage applied to an antenna to be (somewhere out in space) in series with this radiation resistance, Fig. 9 is exactly the same as Fig. 6 (see page 1441, RADIO NEWS for April), and all the discussed phenomena of regeneration apply equally well to an antenna. In view of the known facts when using regeneration with an antenna, this view seems to be the correct one, and may shed new light on the theories of wave propagation.

In explaining the building up of the grid voltage E_g in a regenerative tube, it was shown that the current through R_p would reverse and the regenerating tube would supply power to the signal. In case of an antenna, this means that, instead of power entering the aerial when receiving, the receiving set is radiating energy. This statement also seems unbelievable, but the incredulous reader is referred back to the first part of this article.

RE-RADIATION FROM ANTENNAS

A vertical view of the wave form entering the antenna and leaving is shown in Fig. 10. It must be noted that the exact shapes are as yet only hypothetical, as such measurements are very difficult to make. A side view of the conditions surrounding a regenerated antenna is shown in Fig. 11. The field strength from the transmitting station does not change much in amplitude in the "cross section" shown, while the field strength due to re-radiation falls off very rapidly. However, within quite a range (often as much as a mile) the field strength due to the re-radiated signal is greater than that of the distant transmitter. This fact

$5



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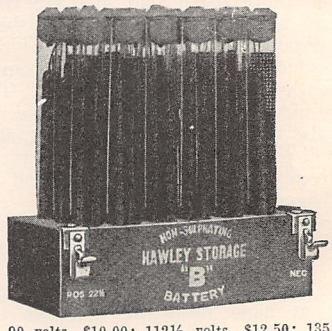

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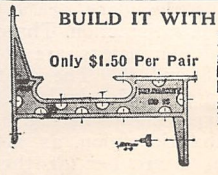

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probably explains many of the crystal detector records.

A consideration of the phase relations of the incoming and re-radiated waves shows alternate interference and addition bands, on both sides of the regenerated antenna. A slight change in regeneration at the receiving set will change both the amplitude and the phase relations of the re-radiated wave. This shifts the interference and addition bands and causes fading, frequency shifting and many other freak conditions.

Now put as many as fifty regenerated antennas in one square mile, and try to determine the reason for freak reception, fading and the hundred and one other things that bother us nightly. One might say that, *in general,* regenerating an antenna will do no harm so long as the oscillating point is not passed. The re-radiated wave is the same as the incoming (minus a few harmonics) and so may enable your neighbor to have more distant reception. So don't forget to thank him if that weak signal suddenly comes up to full loud speaker volume. And you might also try counting to ten when it fades out.

In this somewhat lengthy, though very much compressed article, an attempt has been made to explain the meaning of regeneration and the way it functions in your receiver. Undoubtedly many readers will find questions, doubts, and contradictions. Such must always be the case, when new ideas are presented. Yet perhaps these same doubts and questions will form a basis for an even better understanding of these most useful phenomena of regeneration. If the editor of RADIO NEWS, and the author can form a clearing house, perhaps all of these questions may be answered. In conclusion, one question might be asked: where else can you imagine the functioning of so simple a principle as that of power balance producing so many valuable, and yet so varied results?

Nature's Radio

(*Continued from page* 1522)

However, there were plenty of other sounds which could not be interpreted, and so that phase of Nature's radio still remains as much a mystery as ever. Nevertheless, animals must have some means of communication, although they can not be heard by human ears; and if this communication is not by the medium of a sound, that is inaudible to us, then there is a possibility of its being some sort of radio waves, that up to the present are unknown to man.

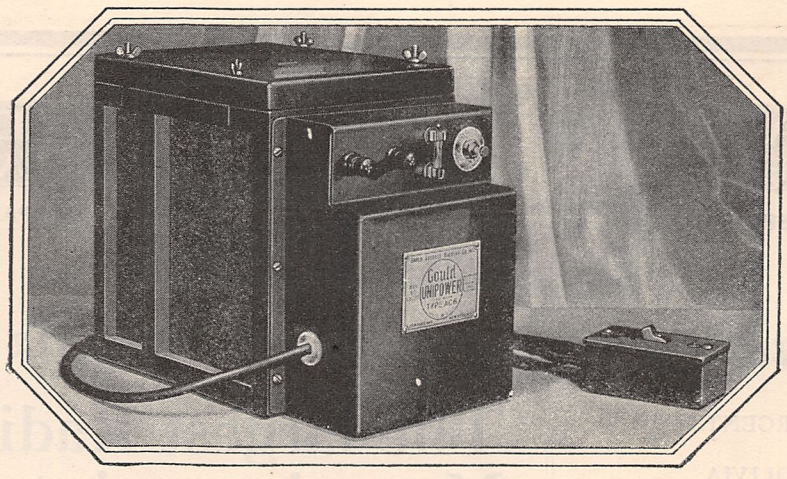
Your Auto and Your Radio

(*Continued from page* 1524)

is connected to an antenna strung back and forth about five times in the roof or top of the car. This will allow one free end of the antenna at each end of the car, for convenience, with the runs spaced about a foot apart. In the writer's sedan flat copper ribbon is used, underneath the top covering and completely out of sight. Flat ribbon is used, because round wire will quickly wear through the covering material.

BATTERY AND IGNITION PROBLEMS

The battery problem is really the hardest. If you use the car battery system, as it comes, reception will be made difficult, or even impossible; depending on the type of ignition, the amount of shielding, the filter used, and the length of wave you try to receive. Short-wave reception is almost impossible when the engine is running, even with a separate "A" battery, unless the greatest care is taken to shield all spark



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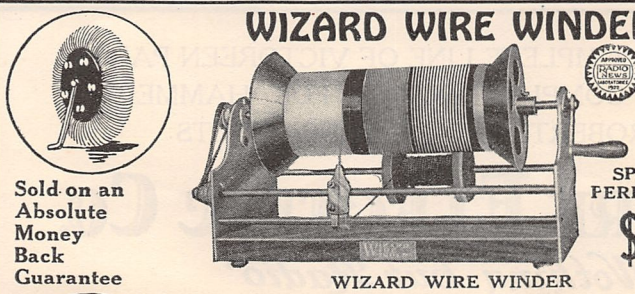

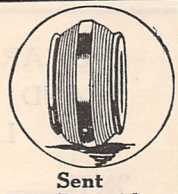

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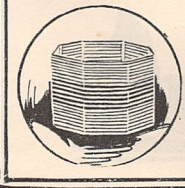

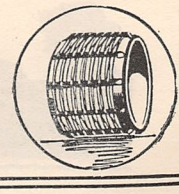

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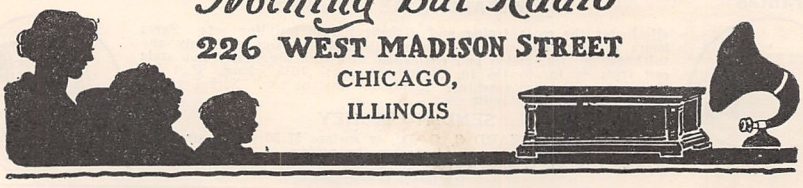


plugs, ignition leads, etc. The natural wave of car ignition systems runs from 6 to 9 meters; but you will easily hear each explosion spark up to 600 meters, unless precautions are taken against it.

If the car battery is used, each spark plug and its lead must be shielded with a metal cover; and in such cases a suitable filter must be used. Of course the car battery may be used with perfect success when the engine is not running.

If magneto ignition is used, you can generally utilize the car battery for your set at all times, by simply filtering out the noises from the charging generator.

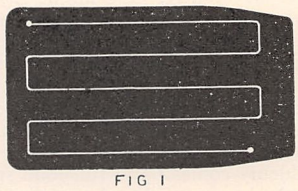


FIG 1

How the antenna is strung in the car's top.

This matter of battery supply is one on which much work can be done, and is the phase of automobile radio that will present the most trouble. The writer has found it most satisfactory to use a separate "A" battery and hang it with the "B" batteries under the floor of the car.

THE RECEIVING SET

The receiver must be both rugged in construction and extremely powerful, because of the limited facilities for signal pick-up. A trial of most types has shown that a good super-heterodyne is the best all-around set to use in a car, in order to assure really satisfactory results. Such changes are taking place in radio that, most people will agree, it is foolish to mar a good car to mount permanently a radio set, when a much smaller or more satisfactory one may be developed and become available at any time.

There is good reason for designing a set as small and compact as possible, and one of the illustrations shows a 7-tube super-heterodyne constructed by the writer for his own use. The receiver, complete with coils and condensers, measures but 18x2x2½ inches; and shows what can be done if one gets down to brass tacks and attempts to make the job as simple and neat as possible. In this receiver the tubes occupy more space than the receiver itself. There are several unusual features, contributing to the compactness of the receiver, which must be left for a future article.

In conclusion, remember always that:

Tuning a radio set is so fascinating that if you attempt it while you are driving the car, you will simply take your life in your hands, to say nothing of the others in your car and on the road. Above everything else, don't attempt it!

WHAT IS DISTORTION?

By A. E. Anderson

(Correction Notice)

Due to an error of the RADIO NEWS Editorial Department the title of Doctor was placed before Mr. Anderson's name, at the head of his article in the April issue, "What is Distortion?" Mr. Anderson disclaims all credit to the degree of Doctor and asks the Editorial Department to make this statement here.

The footnote on the first page of that article refers to Mr. Anderson as "Chief Engineer, General Radio Co." This is likewise an error, as the Chief Engineer of the General Radio Co. is Mr. Melville Eastham, who is also President. Mr. Anderson is the Service Manager of the company.

Instructor: "An electric circuit is carrying one ampere at a voltage of one thousand. Would it be dangerous, and what power does it represent?"

Student: "Yes, it would Kilowatt."

Changes in the Polarization of Radio Waves

(*Continued from page* 1541)

amplification of 1500 was obtained, which proved ample even for the reception and measurement of low-power European amateur stations. By the use of interchangeable coils for the resonator circuit, superheterodyne input and oscillator, a frequency band of from 0.5 to 15 megacycles (600 to 20 meters) was covered.

PROGRESS OF THE TESTS

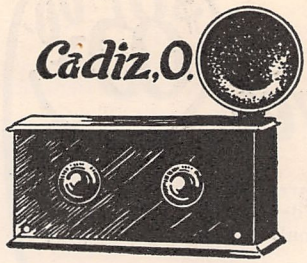
During the month of August, 1925, and principally in the period from one hour before to two hours after sunset (at the receiving point), over thirteen hundred measurements were made, from 379 stations. Most of these stations were operating on the two amateur bands of 3.5-4 and 7-8 megacycles (80 and 40 meters); and the majority were within a 2000-kilometer radius of Seabrook, though a number of European stations were picked up and measured. All of these stations, with the exception of some special transmission from Schenectady, were of the conventional antenna-ground or antenna-counterpoise type, operating either at a harmonic or on the fundamental, so that the wave left the transmitter vertically plane-polarized.

The method of operation and measurement was as follows: With the resonator in any position, but usually at an angle of 45°, a station would be picked up, and the circuits adjusted for maximum signal. The resonator wire would then be swung into the vertical position, and the intensity of the signal noted. Then the wire would be swung to the horizontal, and rotated around a vertical axis until the maximum signal was obtained (this being when the wire was at right angles with the bearing of the distant station) and the intensity again measured. As most of the stations were working in code, and also because of the rapid fading peculiar to these high frequencies, galvanometer readings could not be taken, and audibility readings were used throughout. These readings are approximately proportional to the squares of the intensities of the electric fields involved; and in the final reduction of the measurements the square-roots of the signal-strength ratios were taken as the ratios of the horizontal to the vertical fields.

For frequencies within the broadcasting band of 550 to 1500 kilocycles, either by day or by night, and at all distances, the maximum signal was obtained with the resonator wire vertical; and a low minimum with the wire in a horizontal position; that is, the waves were found to be substantially vertically plane-polarized. During the day time absolute nulls were found with the wire horizontal and at right-angles to the bearing of the station, which meant that the wave had no horizontal component, and was therefore completely vertically plane-polarized. Under night conditions, and for distances of over 50 kilometers, the nulls were replaced by weak signals, the ratios obtained indicating a horizontal electric force of from 2 to 5 per cent. of the vertical force. Measurements of atmospheric disturbances of static were frequently made in the broadcasting band, and in all cases this element was found practically completely plane-polarized vertically.

EXPLANATION OF THE CHART

Very different results were obtained at the higher frequencies. Under night conditions, which in this band begin over an hour before sunset, and last until at least an hour after sunrise, the electric field at any considerable distance from the transmitter is predominantly horizontal. As the frequency increases, the horizontal component also increases; also a distinct maxi-



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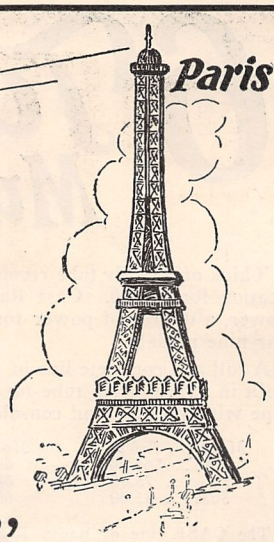

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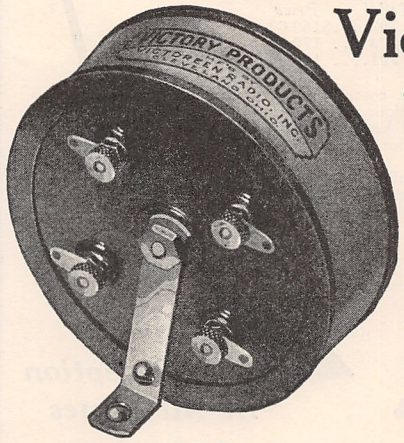

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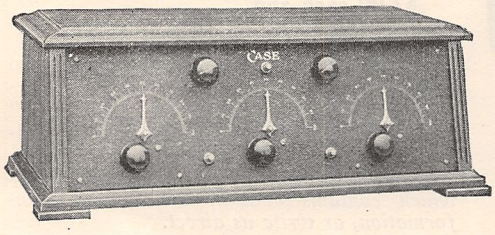

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mum in the ratio of horizontal to vertical field occurs at a distance of about 250 kilometers.

In Fig. 2 I have summed up the result of nearly a thousand separate measurements, principally of amateur stations in this country. The three curves are drawn for the frequency bands centering on 2.8, 3.8 and 7.5 megacycles (107, 80 and 40 meters) and the ordinates are ratios of horizontal to vertical electric field. The heavy line portions of the curves indicate distances at which I had a sufficiently large number of observations to eliminate individual irregularities, while the dotted line portions are for regions where my measurements were few.

Taking first the curve for 7.5 megacycles, the wave leaves the transmitter vertically plane-polarized, without any horizontal component; but before it has traveled twenty kilometers it develops a horizontal component equal in magnitude to the vertical. At 200 kilometers the wave has so completely turned over that the horizontal field is nearly five times greater than the vertical. From then on, however, the ratio slowly decreases, reaching a minimum at a distance of slightly under a thousand kilometers. As the distance still further increases, there is a second increase in ratio; and though my measurements at this distance are relatively few, the European stations at distances of five to six thousand kilometers have a horizontal-to-vertical ratio of between two and three.

The curves for 3.8 and 2.8 megacycles are essentially similar, although flatter. Maxima occur at about 250 kilometers, and minima develop at about 600 kilometers, with a slight rise thereafter. Probably this family of curves could be continued down to the broadcasting band of frequencies; in fact, my measurements of broadcasting stations show that the small horizontal component reaches its greatest value at about 250 kilometers.

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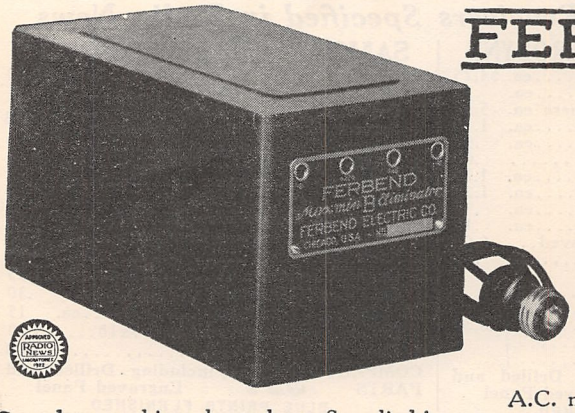

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For frequencies above 7.5 megacycles my measurements are too few for fair averages, but apparently the horizontal component does not continue to increase.

EFFECT OF TERRESTRIAL MAGNETISM?

According to Nichols and Schelleng, the earth's magnetic field is a possible agent in causing a twist in the plane of polarization. If this is so, there should be a difference in ratios, depending upon whether the transmission was along or across the magnetic meridian. The amateur stations measured, in the United States and Canada, subtended at Seabrook an angle of 210°; and if the Cuban and Porto Rican stations are included, an angle of 240°. This gives abundant material for an analysis with respect to direction, that is, with respect to the direction of the earth's magnetic field. This analysis for the frequency bands 3, 5-4 and 7-8 megacycles, gives entirely negative results, so it would appear that the earth's magnetic field is not a large factor in determining the ratio of horizontal to vertical force.

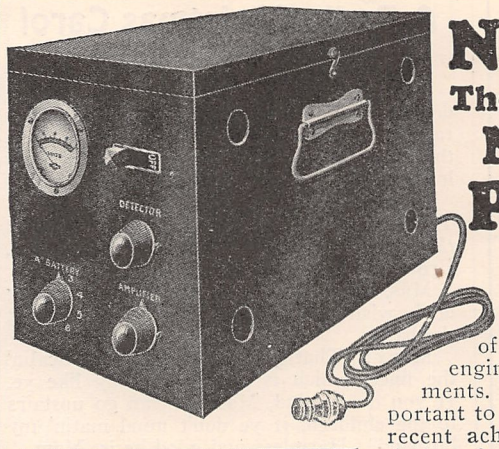
Measurements of static at the higher frequencies were made every evening during August. At 3 megacycles the vertical to horizontal ratio was about 3:1; while at 7.5 megacycles the vertical and horizontal intensities were about equal. A few measurements at 15 megacycles showed no further increase in horizontal component. It is an open question whether the distance of the static sources or their high damping is responsible for these relatively low horizontal components. In a general way we know that the static which affects a receiving circuit tuned to low frequencies comes from a greater distance than does the disturbance which affects a circuit tuned to a high frequency. It is also to be expected that, whatever the mechanism involved in these polarization changes, a single pulse or even a highly-damped train would be acted upon differently from nearly monochromatic radiation. It is, however, obvious that this difference between signal and static is a useful one.

ROTATIONS OF POLARIZATION

Having found that a high-frequency wave, started vertically-polarized, lands principally horizontally-polarized, we should not be surprised to find that a low frequency wave, started horizontally, rights itself and arrives vertically. One of the transmitters at the developmental station at South Schenectady consists of a horizontal doublet running north 30° west, at an elevation of 90 meters, and operated at the broadcasting frequency of 790 kilocycles. Although the wave left this transmitter horizontally-polarized, as received and measured at Seabrook, 250 kilometers away and nearly due east from Schenectady, the plane of polarization was predominantly vertical, the horizontal component averaging 10 per cent of the vertical.

The usual fading was noticed during this transmission, but it was very evident that at times of low vertical intensity, the horizontal component did not decrease in the same proportion; in other words, the amplitude of the fading fluctuations was here distinctly less on horizontal than on vertical reception. A steady-tone modulation was employed in this transmission; and this tone was distorted at all times less on vertical than on horizontal reception, usually being distinctly mushy when the resonator wire was horizontal.

A similar measurement of radiation from Schenectady, made with alternate ten-minute transmissions from vertical and horizontal doublets, at a frequency of 3.75 megacycles, gave an average horizontal-to-vertical ratio of 2.15:1 for vertical transmission, and 2.16:1 for horizontal radiation; that is, they were substantially identical.



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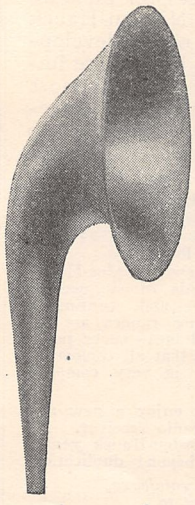

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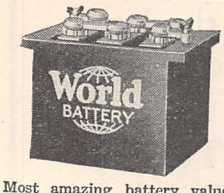

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A Radio Christmas Carol

(*Continued from page* 1530)

do love my husband *very* much, but this radio craze has taken such a hold of him, that I couldn't endure his forgetfulness any longer and . . . I left him . . . and . . .

MARY: Och! Buildin' the radio is it? That's what Mr. Brown does. (*A knock at the door*) There! There! That's Mr. Brown himself, I'm thinkin' and. . .

MRS. B.: Oh, Mrs. O'Heady, I really don't wish to meet him. Can I get out at the back?

MARY: That ye cannot without scalin' the fince, which is not for a lady like ye. If you don't mind, Mam, ye can go upstairs to the children, if ye don't mind matin' my husband! Harmless and good he is, Mam.

MRS. B.: (*Hesitatingly*) Yes, Yes, I'm sure I should prefer to meet Mr. O'Heady. And we'll talk to the children! I can find my way up, so don't try to climb the stairs!

(*The knocking has been repeated and is very loud.*)

MARY: I'm comin'! (*Hobbles to the door and opens it*). Sorry I kept you waitin', Mr. Brown.

MR. B.: Don't apologize, Mrs. O'Heady. I expect you've been listening on the headphones while the children are asleep and that's why you didn't hear me knock at first. But you are looking so young, and blooming! What——

MARY: 'Tis the blarney stone you've kissed, sir, but 'tis indade the happiest Christmas of my life, I'm thinkin'. . .my Dan is home again. . .out sooner for his good conduct and. . .

MR. B.: That *is* splendid news. I was hoping the authorities might be lenient at this season. It is the time of good-will, Mrs. O'Heady and. . .

MARY: Faith, then 'tis Christmas all the year 'round in the heart of ye, sir!

MR. B.: Who said Blarney? Now, now! But I must be going. First, please give these toys and candy to the children for tomorrow, while you and I being matter-of-fact grown-ups, Mrs. O'Heady, you shall open this parcel now—that is your Christmas gift!

MARY: (*Excitedly*) 'Tis beautiful! 'Tis a thousand. . .

But before the music starts, sir, 'tis another great favor I'll be bold to ask, Mr. Brown.

MR. B.: Well, Well, that sounds sort of mysterious. What can I do for you?

MARY: Oh! I nivir asked ye before, Mr. Brown, but it's thinkin' that married ye are, Sir. A single man would nivir be so understandin' of things as ye are. May I make bold to ask if your good lady is one that does not like too much radio buildin'?

MR. B.: (*Puzzled*) Oh, it must be a common complaint and evidently you seem to know it. Well,. . .

MARY: Faith, Sir, 'tis anxious I am to help ye, like the little she-mouse helped the big fine lion! And my heart tells me 'tis not happy ye are!

MR. B.: (*Hesitatingly*) Your intuition is correct, Mrs. O'Heady! I must confess that I did overdo my hobby of radio experimenting, to such an extent that I'm afraid I neglected my wife, and. . .she has not yet forgiven me!

MARY: Och, but ye do *love* your wife, Mr. Brown, or ye would niver fear for the results of the askin'! Now, Sir, 'tis a woman I am, and there is no grate diffrence betwixt women whin they love with all their heart! I feel sure that your wife *must* love ye truly, and lovin' how can she help forgive ye? The favor that I'm askin', Sir, is your promise ye will not shirk askin' her this very night!

(*Dan rushes downstairs and up to Mr. Brown*).

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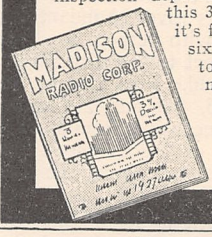

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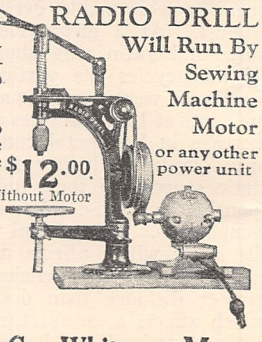

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DAN: That gintleman, Mary, is my lawyer who got me off with such a light sininee, and iver since has stuck by me.—What's more, Mary, 'tis he that has sent ye money iver since I was locked up and his name is not Brown, tis *Brockhart! Brockhart* it is!

MR. B.: Goodbye, Mrs. O'Heady; Merry Christmas!

MARY: Glory be! 'Tis the hand o' God it is! Such a Christmas! Dan, Dan will ye go upstairs and ask the lady to take a step down?

MR. B.: Now, Now, I really must be going, Merry Christmas! (*Makes for the door*). Dan, come to this address and see me. There's a job as foreman waiting for you at a small place I have in the country! Goodbye! Merry Christmas! (*Is opening the door*).

MARY: Quick, Dan, Stop him on your life! (*Dan jumps and bars the door*). Mr. Brockhart, *'tis your own wife* that's upstairs, and she's achin' for ye: 'tis Mrs. Brockhart herself, I tell———

MR. B.: Good God! (*Dashes off upstairs*).

DAN: Mary, Mary, ye *are* a wonderful woman, I tell ye agin and agin.

MARY: Faith, 'twas touch and go. . .and my two best frinds aplayin' at cross-purposes, at Christmastide too! 'Tis the radio that's parted them and 'tis the blessed radio sure that's brought them together agin! God bless the Radio!

THE END.

Radio Wrinkle Contest

(*Continued from page* 1569)

the "B" battery terminals, one lead to the minus B and the other to the B plus detector. There should be no circuit and the tube *should not light.* If it does, it is an indication that the "B" battery circuit is connected to the filament circuit; and of course if the "B" batteries were connected to the receiver it would burn out the tubes. The lead on the 45-volt jack should be moved over to the 90 B and 135 B terminals, and the test repeated. When test has proven that there is no short circuit, then all the batteries may be connected and the tubes inserted in the sockets.

I Want to Know

(*Continued from page* 1578)

entire filter circuit. This controls regeneration and volume. The grid-leak, R1, and condenser, C2, may be 2-megohm and .00025-μf., respectively. The "B" battery should not exceed 67 volts on the detector."

The set can be built into a 7x12-inch panel and cabinet. The filter variable condenser C5 should be mounted on the left of the panel and the secondary condenser C1 on the right. The filament rheostat R2 and filter resistance can be mounted vertically in line between these condensers, with the latter on top. The six-inch tube should be mounted vertically, with the primary and the first filter coil in position behind the filter condenser. The terminals of the coils should be brought through holes bored in the tube with a 1-16-inch drill, and their position should be near their terminal connections.

By using a 7x10-inch hard-rubber panel for a baseboard, mounting it to the main panel with brass angles, a first-class job can be made of the wiring, which may be concealed beneath the panel. On the front of the panel are mounted the aerial and ground binding posts; and on the base-panel are mounted the "A" and "B" battery binding posts.

The operator will develop his own system of tuning the set, but in general he will find that the two variable condensers tune with about the same settings, and that stations are picked up best by advancing the filter condenser slightly more than the secondary condenser. Clearing up distant stations is done by turning the filter condenser slightly behind the position of the secondary condenser. A point of adjustment is found on the filter resistance where signals over a given wave-band may be received without further adjustment of that unit. With this set a long aerial can be used to advantage, as none of the interfering problems common to other one-tube sets are encountered.

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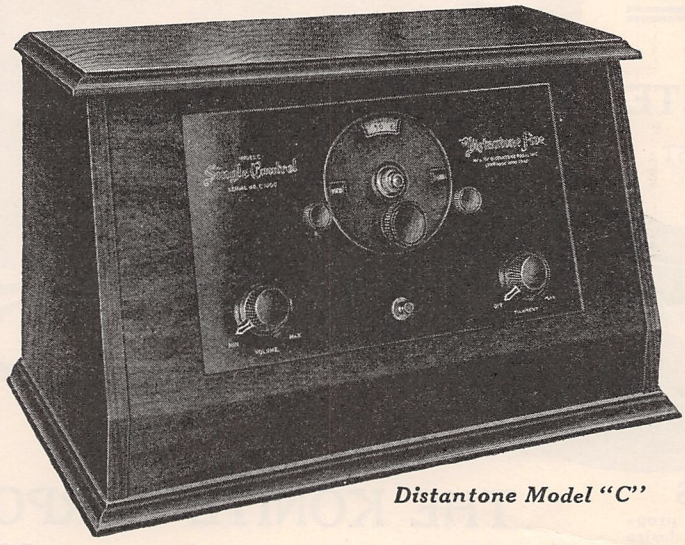

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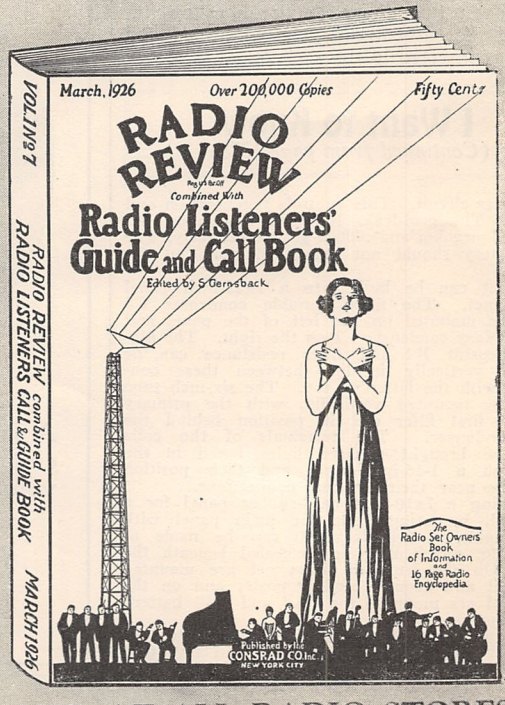
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Thirty Years in the Dark Room

(*Continued from page* 1543)

Today more and more attention is being given to the production of specific vacuum tubes for particular purposes, for example by the use of quartz with mercury vapor. Moore believes that it is the light of the sun with the proper admixture of ultra-violet rays, rather than its heat, that causes plants to grow. Therefore, at night or on dark days, a light similar to daylight might be substituted.

In 1921 Moore turned again to the gaseous conductor lamps. Fig. 5 shows one that he calls a low-voltage, self-starting, neon-tungsten-arc incandescent lamp; that is the luminosity is due to both heated tungsten wire and electrically agitated gas. He discovered that if two small tungsten helices were placed about $\frac{1}{16}$-inch apart in a tube filled with neon gas, a low voltage would cause first the comparatively faint negative glow, which would start an arc, and that in turn heated the tungsten to incandescence.

A GASEOUS-FILAMENT LAMP

Another wonderful light that Moore developed solved a problem that he had been working on for many years. It is a positive-column light, and is shown diagramatically in Fig. 6. Low voltage, 1-2, applied to the two electrodes, 3-4, can not of itself cause a positive column in 5, but it can cause a negative glow on 6-7. The emitted electrons bridge the short gaps from 6 to 3 and from 7 to 4; so that at first very small current flows from 1 to 2. However, the potential on 3 and 4, even though it is low, sweeps the electrons thus continuously generated into 5; so that it becomes a sufficiently good conductor to be filled with an intense positive column of light. Moore admits that further developmental work is necessary before the internal diameter of 5 can be made small enough to simulate more completely a gas filament; but theoretical considerations and the results already obtained constitute such an important event, that it is believed this is the progenitor of a new race of lamps.

Its theory of action may be said to be the reverse of that of the audion; that is, the grid of the audion stops the flow of the electrons, while the ignition electrodes of the positive-column lamp starts them. This new lamp has many possible applications, including the "teloramaphone," or seeing-and-hearing radio.

Due to Moore's enthusiasm for radio, long before it was born, it was quite natural that, within a few days after the now famous pioneer station WJZ started, he should outline the development probable with radio; and also construct a receiving set. He believes that the wireless transmission of power is possible and that world advancement needs also the "opigraph" (a voice writing machine); and that the latter, perfected through the use of some kind of vacuum tube, will be one of the great Peace agencies that will finally banish war from the earth.

He has mapped out his work for at least the next decade and looks forward to each day's development of general science with an absorbing zest. The present speed of world-change is almost appalling; yesterday the earth was "raw" material, today it seems to be almost "finished in the rough." Invention is the basic reason for today's serious peace considerations. Man has conquered the land, the water, and the air—nothing else comparable to conquer except himself. Mr. Moore believes that worship of the Creator is the absolutely necessary factor of civilization's permanence.

THE END.

LOOK to your TUBES!

if you want better reception

WITH a Sterling Tube Tester, you can instantly find out whether reception that has become weak in volume or poor in quality is due to low plate current in your tubes.

And don't forget that a single weak tube may practically ruin your results. Sterling Tube Testers are also valuable for locating other set troubles. They plug right into your tube sockets.

The Sterling "Metered" Tube Reactivator will revive weak and overworked filaments in your tubes. Because it is meter-equipped, it will tell you *when* filaments need treatment and *just how good* they are afterward. There is no guess work.

Save tube expense, and get clear, enjoyable reception by servicing your tubes at home with these reliable Sterling Radio Specialties.

Sterling Tube Tester		Sterling Tube Reactivator	
R-399 for small tubes	$10.00	(50-60 cycle)	$12.50
R-401 for large tubes	8.50	(25-40 cycle)	14.00

Ask your dealer or write the factory

THE STERLING MFG. CO.
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Sterling
TUBE TESTERS *and* TUBE REACTIVATORS

Goodrich
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For greatest range and selectivity

1 Easier to drill and machine.
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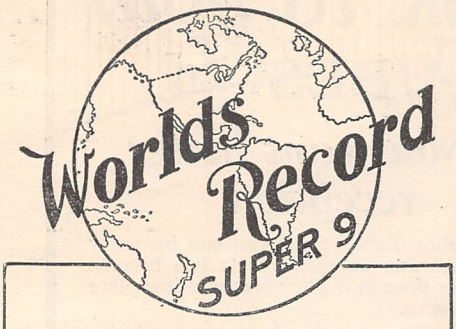
BUILD



the RECEIVER that Holds 4 World Records All Fully Verified

(1) Longest distance ever received on a loop aerial—8,375 miles.

(2) Most consistent reception of stations 6,000 to 8,000 miles distant—117 programs in three months.

(3) In 2¼ hours, brought in six different stations—all over 6,000 miles distant.

(4) Received greatest number of stations located 6,000 or more miles away.

NEW REPORTS

Dr. Sidney Kuh of Chicago, Illinois, writes: "Have certificate showing reception 2LO London on my Worlds Record Super 9 in spite of adverse conditions test week—some accomplishment for any receiver."

Last year a Worlds Record Super 9 brought 2LO into Chicago with loud speaker volume on a loop.

Mr. M. F. Beaudoin, Winter, Wisconsin, writes: "Constructed Worlds Record Super 9 with your parts and instructions—On North Woods trip picked up 118 stations in six hours—Got Australia, Mexico, Alaska and Cuba—California stations came in like locals—Have tried best receivers made—Yours (The Worlds Record Super 9) outpoints them all."

ALL THE PARTS

Send for data on all the parts necessary to make an exact duplicate of this marvelous receiver together with a complete book of instructions, blue prints, etc.

FREE Mr. Scott's story of the development of his master receiver and proofs of its record-breaking performances sent on receipt of stamped and addressed envelope.

Dealers and set builders, write for discounts.

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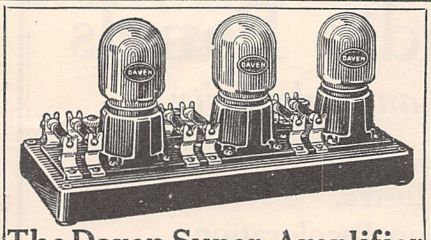

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3 STAGES RESISTANCE COUPLED
ECONOMICAL DISTORTIONLESS
Easily added to any set
Saves Several Hours' Assembly
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LATEST "COAST TO COAST" FULLY GUARANTEED
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Users everywhere report Miraco Radios get programs coast to coast on loud speaker; outperform sets three times as costly. Many hear foreign countries. Radio's most amazing values in unconditionally guaranteed, factory-built long distance sets—let testimony of users convince you.

MIRACO RADIO GETS 'EM COAST TO COAST

Powerful New Multi-tube Miraco gets long distance on loud speaker. Sets ONLY . . . . . $27.35 retail

FREE! Literature on latest improved 1 to 5 tube models, new low prices, testimony of users and SPECIAL OFFER. Write:

MIDWEST RADIO CORP'N
Pioneer Builders of Sets
404E E. 8th St. Cincinnati O.

AGENT USERS WANTED
Write for discounts.

A 110-Volt Filamentless Tube

(*Continued from page* 1547)

diameter, so as to include the cylindrical grid and plate elements. The inner face of the thimble is coated with the electron-emitting compounds and the heat is applied to the thimble from without, instead of from within. The chief advantages and differences of the second type over the first type are:

(1). It may be made more compact.

(2). It contains much less glass in its construction and may be almost entirely covered over with the metallic shell shown in Fig. 6, and hence it is practically non-breakable,

(3). The most remarkable feature of type two is that any source of heat may be used to heat the thimble of this tube; for instance a gas burner or an alcohol lamp may be conveniently used. In fact, the author used a Bunsen burner in exhausting and operating one of these tubes, very satisfactorily.

One possible disadvantage of the second type of tube, as compared with the first, is that it takes approximately 75 per cent. more energy to heat it. To make this statement more concrete, the first form of tube operates on about 15-watt input energy; and even this is materially cut down in the latest designs. Hence the total wattage required to operate the average 5-tube set will be not much more than 50 watts; whereas, with the second type of tubes, the energy consumption will be more nearly 85 watts.

It is impossible in this article to go into a technical discussion of the characteristics of these tubes, and reproduce the curves obtained in laboratory tests. Suffice it to state that the operating characteristics of the latest designs of the Type 1 tube, are approximately the same as those of the best 201-A tubes now made. Of course, the design of a tube of this type is extremely flexible, but standard characteristics were chosen for convenience. It is worth calling attention to the fact that with a thimble-cathode of the proportions used in these tubes, it is very easy (in fact almost unavoidable) to obtain quite low values of plate impedance; hence in order to keep the mutual conductance within the range of the ordinary tubes, it is necessary to make the amplification constant also rather low.

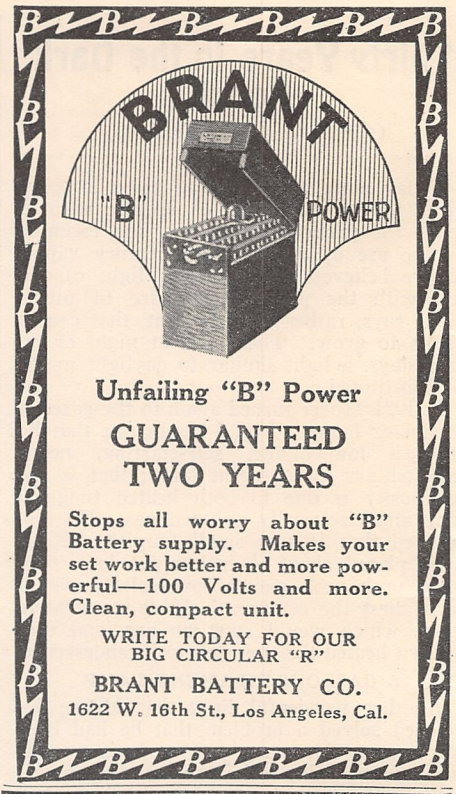
Problems of a Radio Program Director

(*Continued from page* 1535)

should he arrange to present his trios, quartettes, and other chamber music, his symphonic orchestras, his grand opera presentations? Shall they be given without explanation, without setting; or do they need something else which will open the mind, and arouse the imagination of the listener?

It is one thing to *plan* to present grand opera, symphonic music, concert programs. The next thing is to find the artists. The big artists are engaged with the opera companies, their contracts forbid them to broadcast. Or if they are not with the opera companies, they are demanding huge fees. What inducements can be offered to bring them to the station, to devote the time to rehearsals and performances?

Then, after the music, comes the theatre. How shall he bring in the theatrical companies, and induce the members of the casts to come up after their heavy performances? What shall be selected from the play, what is good in the play, what is interesting to the listeners? And so on down the line, ad infinitum.



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Stops all worry about "B" Battery supply. Makes your set work better and more powerful—100 Volts and more. Clean, compact unit.

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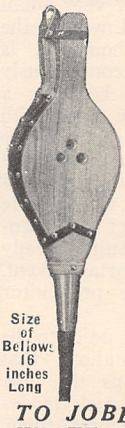

Size of Bellows 16 inches Long

You will not get satisfactory results if you allow dust to collect between the plates of your variable condensers. You can thoroughly, quickly, safely and easily remove the dust in your set with the

LITTLE MARVEL RADIO BELLOWS

Special rubber tip prevents damage from contact. Frequent use of the LITTLE MARVEL keeps your set at its highest efficiency.

Sent Postpaid anywhere in U. S. upon receipt of $1.50. Money refunded if not satisfactory.

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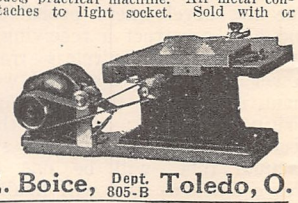

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Certified Radio Parts

Learn Watchwork, Jewelrywork and Engraving A fine trade commanding a good salary, and your services always in demand. Address Horological, Dept. 5, Bradley Institute, PEORIA, ILLINOIS, for our latest catalog.

THEY CAN'T SING—AND WILL SING

Of course, the program director is assailed by thousands of offers. Here are men and women who have the greatest subjects in the world—so they think—and so their friends sometimes think. Important officials, associated with companies in some way doing business with a station or its associate companies, have their favorites whom they want to put on the air. How to eliminate these is another problem of the program director: how to know how to drop what is not essential or of sufficient interest.

There may be something extremely interesting, entertaining, important, on the program; how can we let the public know about it?—there is another question. How make the newspapers realize that here is an offering which deserves attention?

I mention some of these things because, as our listeners coming behind the scenes at WRNY would quickly realize, what is presented on the air is not haphazard, is not without its advance development and preparation. Fifteen minutes and a whole idea has come and gone. You have heard it—you have forgotten it; and yet weeks and months have gone into the development of that fifteen minutes. Often listeners are entirely too off-hand with their attitude toward that which they hear on the radio.

WHAT YOU OWE TO RADIO

To be sure it is given to them. It comes from this station, that station or the other station. You can tune in to any station at any time, or tune it out at any time. Imagine that you could walk down Broadway in New York, or State Street in Chicago, and into any theatre at will; and walk out again without any payment, or even "I thank you." Imagine that! And yet that is your situation on the radio.

It, therefore, becomes not only your privilege but your duty to help—help the program director, help the artists, help the stations—not only WRNY, but every other station. Otherwise, radio is going to make us entirely too lazy, too indifferent, to our own responsibilities.

I am reminded of the statement once made by a public speaker who said: "The reason I object to socialism is not that it divides property and gives a closer and equal division of opportunity, but because it fails to carry with it a division of responsibility. If socialism will say to me, 'Yes, let us divide property, but let us also divide duties and work,' I would be for socialism to the last

40 Non-Technical Radio Articles

every month for the beginner, the layman and those who like radio from the non-technical side.

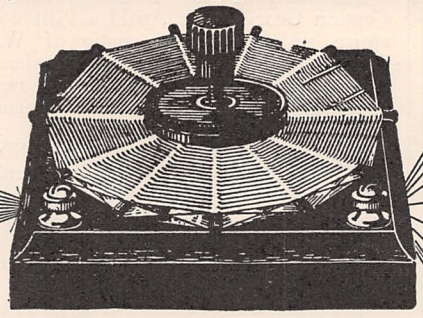
SCIENCE & INVENTION, which can be bought at any newsstand, contains the largest and most interesting section of radio articles of any non-radio magazine in existence.

Plenty of "How To Make It" radio articles and plenty of simplified hook-ups for the layman and experimenter. The radio section of SCIENCE & INVENTION is so good that many RADIO NEWS readers buy it solely for this feature.

Radio Articles Appearing in the May Issue of "Science and Invention" Magazine.

Radio Entertainment of the Future, by Jack Milligram.
How a Vacuum Tube Operates, by Abner J. Gelula.
The Radio Constructor—How To Build a Highly Efficient Short-Wave Receiver, by Leon L. Adelman, 2AFS and Alfred R. Marcy, 2DK.
Experimental "D" Coil Couplers, by Herbert E. Hayden.
Radio Oracle—Radio Questions Answered.
Radio Wrinkles.

Steinite Low Loss Interference Eliminator



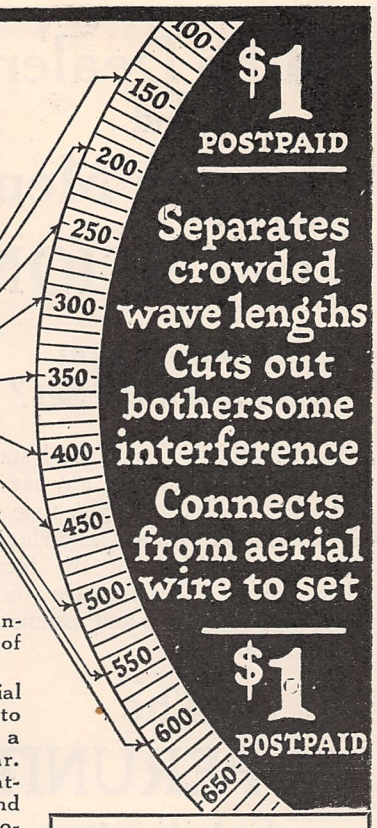
Give Your Receiver a Chance —

Day by day radio reception is becoming more involved—few sets are built for wide distribution of stations—crowding results.

This amazing eliminator attached to your aerial wire, gives your set a chance, it enables you to select stations at will. You get one station at a time, the one you want and tuned in loud and clear. Helps in all sets. Requires no extra tubes or batteries. Put this eliminator on your set to-day and note the amazing improvement. Installed in a moments time.

Price $1.00 Post-Paid. Money Back Guarantee.

STEINITE LABORATORIES
127 RADIO BLDG. ATCHISON, KANSAS



$1 POSTPAID

Separates crowded wave lengths
Cuts out bothersome interference
Connects from aerial wire to set

$1 POSTPAID

Mfrs. Famous 1,500 Mi. Steinite 1-Tube Set, $6; Long Distance Crystal Set, $6; Steinite Crystal 50c—Three for $1

Steinite 5-Tube Set $29.75

Free Descriptive Literature on Request.

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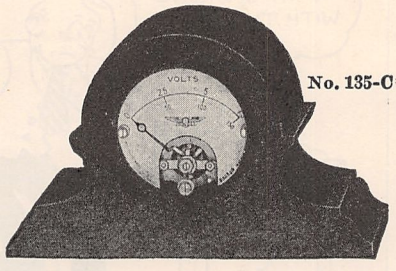

No. 135-C

The Control

of your tube filament is very essential. The life of a tube is shortened if burned too high.

Use a Jewell High Resistance Voltmeter No. 135-C, supplied with cords, plug and adapter for plugging into jacks on panels of Radiola, Victor and Brunswick sets.

Send for Circular No. 739

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The New Magazine of Scientific Fiction
JUST OUT
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1926 **FREE RADIO GUIDE**
NEWEST 1926 EDITION

Shows the latest circuits, the newest developments in radio at startlingly low prices. Get the parts you want here and save money. The best in parts, kits, sets and supplies. Orders filled same day received. Write for free copy NOW; also please send names of one or more radio fans.
BARAWIK CO., 102-142A So. Canal St., Chicago, U.S.A.

Radio Dealers and Service Men ATTENTION!

How do you test a Radio Set?

Do you tune in some local station that is so powerful that any set will give good results? Do you tune in a distant station without knowing the receiving conditions of the locality where the set is located? Do you test the tubes and battery and assume that the set is O. K.?

The "SUPERUNIT" Set Tester

answers these questions

It measures 5 x 6½", contains no batteries whatever and operates direct from the house lighting current. It will provide a clear audible note and can be set to radiate on any wave length from 200 to 600 meters. The dial is calibrated and the wave can be detected by an average set at a distance of 100 feet. This device contains no movable parts, except a variable condenser.

Sent C. O. D. subject to inspection for $6.75

Hanscom Radio Devices

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Manufacturers of the S-C Capacity Element, an ideal device for single control licensed under Hogan's patent No. 1,014,002.

You Can Succeed in Radio--- He Did!

Richard Leach, only 21 years old, graduated six months ago from the "Y" Institute and is now Chief Radio Operator on the big S.S. Peter H. Crowell—seeing the world in a pleasant and profitable job.

Radio offers the same opportunities to you.

Learn Radio at home in spare time or at our big School in New York City. Courses for Radio Operators, Mechanics, Broadcasting, Dealers, etc.

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degree." Radio listeners can help radio broadcasting and radio development by devising a way of aiding program directors and artists in lieu of the fact that they cannot pay for their entertainment under the present system.

RECENT ACTIVITIES AT WRNY

The hero of the "President Roosevelt," Captain George Fried, paid a visit with his entire retinue, to the studio of WRNY. Captain Fried spoke feelingly about the American merchant marine and the need for its development; and Mrs. Fried made her only public address over the radio. In remembrance of the occasion, WRNY will present Captain Fried with a gold embossed memento, which he will receive on his return to New York. WRNY broadcast also the reception to Captain Fried in the Winter Garden and in the ballroom of the Roosevelt.

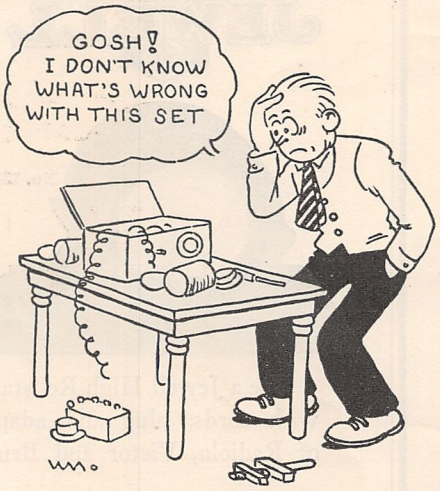
The RADIO NEWS Prize Play, "The Hidden Witness," was effectively presented by the Radio Theatre Players, under the direction of Al. Rigali.

Among the newcomers to WRNY are Richard Hageman, one of the world's greatest conductors; Lazar Samoiloff, teacher of eminent artists such as Rosa Raisa and others; A. Seismit-Doda, Julian Huarte, the Spanish composer, Victor Wittgenstein, Madelaine Braid, Claude Warford, and Sergei Klibansky; and so on through a long list of eminent names. The pipe organ has been added to WRNY's instrumental series. Rock Ferriss, who is the conductor of these organ recitals, has been chapel organist at Princeton Universty.

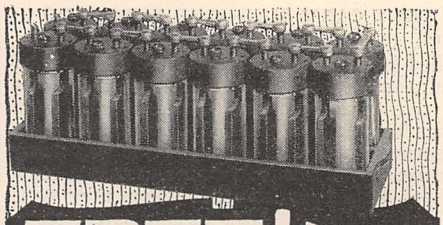
In the "Up and Down Broadway" Review, the Yiddish Art Players, producing the famous success,. "The Dybbuk," broadcast; as did the cast of "A Weak Woman," "Port o' London," and other companies.

The Catholic Circle brought Father Wynne; the Jewish Circle, Dr. Lee Frankel; and the Protestant Circle got under way with the Rev. Mr. Megaw.

Many interesting novelties were added on Novelty Night, which included a Lincoln's



A Pretty Poor Rectifier



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12-Cell — 24-Volt Storage 'B' Battery

Positively given **free** with each purchase of a WORLD "A" Storage Battery. You must send this ad with your order. WORLD Batteries are famous for their guaranteed quality and service. Backed by years of successful manufacture and thousands of satisfied users. Equipped with *Solid Rubber Case*, an insurance against acid and leakage. You save 50 per cent and get a

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6-Volt, 100-Amperes	$11.25
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12-Volt, 7-Plate	16.00

Send No Money Just state battery wanted and we will ship day order is received, by Express C. O. D., subject to your examination on arrival. **FREE** "B" Battery included. **Extra Offer:** 5 per cent discount for cash in full with order. Buy now and get a guaranteed battery at 50 per cent saving to you.

Approved and Listed as Standard by Leading Authorities including Radio News Laboratories, Popular Science Institute of Standards, Popular Radio Laboratories, Radio Broadcast Laboratories, Radio in the Home, and Lefax, Inc.

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1219 So. Wabash Ave., Dept. 10 CHICAGO, ILL.

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Selling 40 to 550 Meter Set

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Public wants this Amazing New Set. Coast-to-coast reception. Receives all waves, 40 to 550 meters. Shot sub-panel makes assembly quick and easy. We need distributors everywhere. Demonstration sells. We carry stock. Set sells at half store prices. $60 to $100 weekly easily made.

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Our Special Plan trains you in Radio—gives you a **Free Demonstrator Set** and appoints you as distributor. The entire cost is less than regular dealer's price for Set alone. Hundreds are making big money in spare time. Get started now while territory is still open. **Write Today!** Don't miss this opportunity to make a fortune in Radio. Get complete training and sales plan **Free! AMBU ENGINEERING INSTITUTE**
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OHIO Motor Generator CHARGER

A real Motor-Generator with no bulbs to break—no chemicals to renew—no contacts to burn. Charges in one-third the usual time or several batteries in parallel. Capacity 3 to 18 amperes at 6 to 10 volts. Also made up to 250 volts. Merely hook to light socket—Fully automatic—Weighs 60 lbs.—lasts a lifetime—In writing state if wish to charge both "A" and "B" Batteries.

Satisfaction guaranteed or money back.

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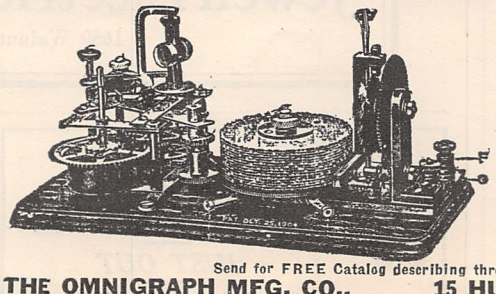

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THE OMNIGRAPH Automatic Transmitter will teach you both the Wireless and Morse Codes—**right in your own home**—quickly, easily and inexpensively. Connected with Buzzer, Buzzer and Phone or to Sounder, it will send you unlimited messages, at any speed, from 5 to 50 words a minute.

THE OMNIGRAPH is not an experiment. For more than 15 years, it has been sold all over the world with a money back guarantee. The **OMNIGRAPH** is used by several Depts. of the U.S. Govt.—in fact, the Dept. of Commerce uses the **OMNIGRAPH** to test all applicants applying for a Radio license. The **OMNIGRAPH** has been successfully adopted by the leading Universities, Colleges and Radio Schools.

Send for FREE Catalog describing three models. DO IT TODAY.

THE OMNIGRAPH MFG. CO., 15 HUDSON STREET, NEW YORK CITY

If you own a Radio Phone set and don't know the code—you are missing most of the fun

Day Birthday program, a Poets' Symposium, and the "Presidential Inaugurals." Perhaps you listened in when Texas Guinan and Vincent Lopez and nearly fifty other popular entertainers were on the air.

The Debut Hour is now under way. Each Monday night new talent is presented to WRNY's radio audience and the feature, inaugurated only recently, has become a very popular one.

I will see you again next month.

New Developments in Radio Apparatus

(*Continued from page* 1545)

should look closely at the other end of the meter scale before he cries; for there he will find a scale having three colors instead of the familiar figures. These colors are green, yellow and red; and if he is familiar with railroad signals he will find a similarity. Beneath the green section of the scale is marked "Full;" beneath the yellow strip will be found "½," and under the red part, which is universally known as Danger, is found "Too Low." The needle of the meter is sent to that end by merely pushing the small button in the middle of the meter. So with one of these meters installed on a receiver there really is not a great deal of excuse for not knowing the condition of a storage battery.

The other small meter is one of the more familiar type. This is also mounted on the front of the panel, is used to determine the amount of voltage at the terminals of the "A" and "B" battery, depending on the manner in which the meter is connected. This type of meter can be obtained in several different ranges, for reading the voltage, as well as the current delivered by a battery.

The largest of the meters in the illustration should delight the heart of an experimenter, for it is really five meters in one. By connecting leads to the different binding posts two voltages can be read, 0-7.5 and 0-150. The current ranges are 0-15 milliamperes, 0-75 milliamperes and 0-7.5 amperes, these being about the only ones needed by the experimenter in the radio field.

The person who is familiar with meters in general will wonder, where is the switch to throw the different resistances, that are necessary, into the circuit? This switching is taken care of in quite a unique manner. The outside rim of the round meter case is knurled, providing a grip to turn the case. This is the only switch that is necessary. An arrow on the side of the case indicates the voltage or the current to be read. For instance, suppose we wish to test the voltage of our "B" battery. We will connect the leads to the two binding posts marked 150 volts and turn the meter case until the arrow points to the same designation. The reading of the battery will be found on the upper scale of the meter, which is 0-150.

The intelligent use of batteries should be cultivated by the radio fan. These little instruments are not so very expensive, and upon several occasions we have been repaid the price of the meter, many times over, in the saving of tubes. After a set is built, a voltmeter is a mighty handy instrument to have, in order to check up on the wiring and see that we are not trying to light the tubes with 90 volts or something equally foolish.

NEW QRA'S

5WC—J. B. Gaines, 203 S. Clinton St., Dallas, Tex.

4AAD (portable) **4MC**—J. H. Shaw, 765 Bonnie Brae Ave., S. W., Atlanta, Ga. All qsl's answered promptly. Am using one 203-A and one 202.

2AHU—Benjamin L. Berger, 166

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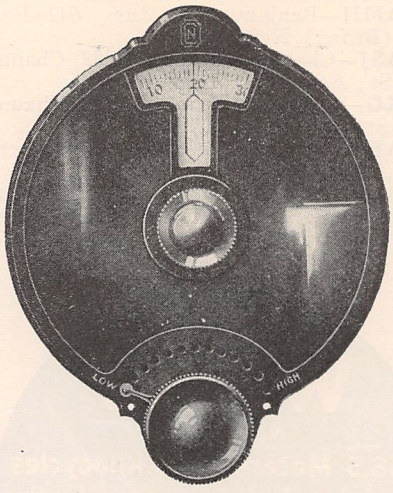
Type B, Variable (Patent Pending)

Positive Control—Easily Mounted



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YOU control the reduction ratio with this new NATIONAL Type B, Velvet Vernier Dial. And what a difference in the tuning of your set! You'll be astonished.

Easily mounted on the 1-4 in. shaft of any standard type of variable condenser. A screw driver is the only tool you need.

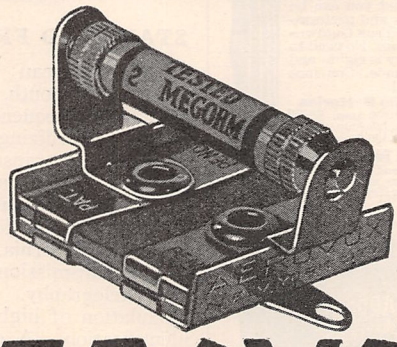
It has the same velvety smoothness, the same freedom from backlash, the same mechanical drive as the NATIONAL's famous Type A dial.

Write for Bulletin 109RN

NATIONAL COMPANY, Inc.

W. A. READY, President

110 Brookline Street, Cambridge, Mass.



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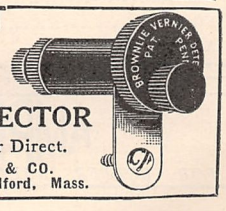

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is owned and operated by the publishers of this magazine
Our Editors will talk to you several times every week-
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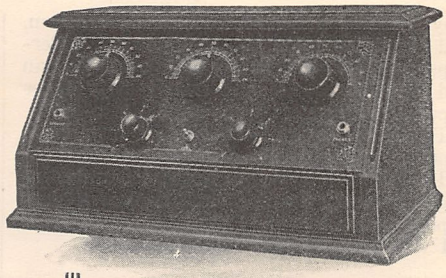
TUNE IN ON WRNY

STANDARD FREQUENCY SIGNALS

THE Bureau of Standards transmits, twice a month, radio signals of definitely announced frequencies, for use by the public in standardizing frequency meters (wavemeters) and transmitting and receiving apparatus. The signals are transmitted from the bureau station WWV, Washington, D. C., and from station 6XBM, Stanford University, California.

The transmissions are by continuous-wave radio telegraphy. The signals have a slight modulation of high pitch which aids in their identification. A complete frequency transmission includes a "general call," a "standard frequency signal," and "announcements." The "general call" is given at the beginning of the 8-minute period and continues for about 2 minutes. This includes a statement of the frequency. The "standard frequency signal" is a series of very long dashes with the call letter (WWV or 6XBM) intervening. This signal continues for about 4 minutes. The "announcements" are on the same frequency as the "Standard frequency signal" just transmitted and contain a statement of the frequency. An announcement of the next frequency to be transmitted is then given. There is then a 4-minute interval while the transmitting set is adjusted for the next frequency.

The signals can be heard and utilized by stations equipped for continuous-wave reception at distance within about 500 to 1,000 miles from the transmitting stations. Information on how to receive and utilize the signals is given in Bureau of Standards Letter Circular No. 171, which may be obtained on application from the Bureau of Standards, Washington, D. C. Even though



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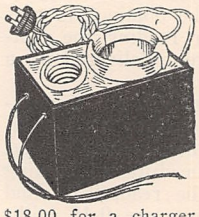

Trickle Charges any type of storage A or B battery, or auto battery, using a few cents worth of ordinary house current. Cannot injure battery and lasts for years. Complete directions enclosed—anyone can operate. No "Extras" to buy.

Why pay $10.00 to $18.00 for a charger when you can get this splendid GUARANTEED R. B. Charger by mailing us two dollars (bills, money order, check or stamps). Charger will be sent postpaid. Act at once. TODAY.

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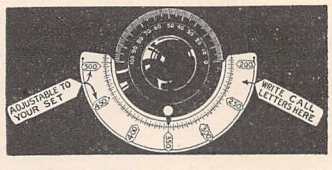
Now you can easily adjust your set exactly to the wave-length of the station you want to hear— Greatly simplifying tuning.



Can be placed either above or below any dial not over 4 inches in size. Very simple to attach; no tools needed.
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AMAZING STORIES MAY, 1926

In This Issue:

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"THE RUNAWAY SKYSCRAPER," by Murray Leinster. A story of the Fourth Dimension, in which the 50-story Metropolitan Life skyscraper vanishes into the Fourth Dimension. One of the most surprising tales we have ever read.

"WHISPERING ETHER," by Charles S. Wolfe, a radio story that holds your interest and is responsible for a good deal of gooseflesh, and chills running up and down your spine.

"OFF ON A COMET," by Jules Verne (conclusion).

A number of other short stories by well-known scientifiction writers.

Be sure to get your copy today.

The magazine is edited by Hugo Gernsback.

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AT ALL NEWSSTANDS

only a few points are received persons can obtain as complete a frequency meter calibration as desired by the method of generator harmonics, information on which is given in the Letter Circular.

The schedule of standard frequency signals from both the Bureau of Standards and Stanford University, is as follows:

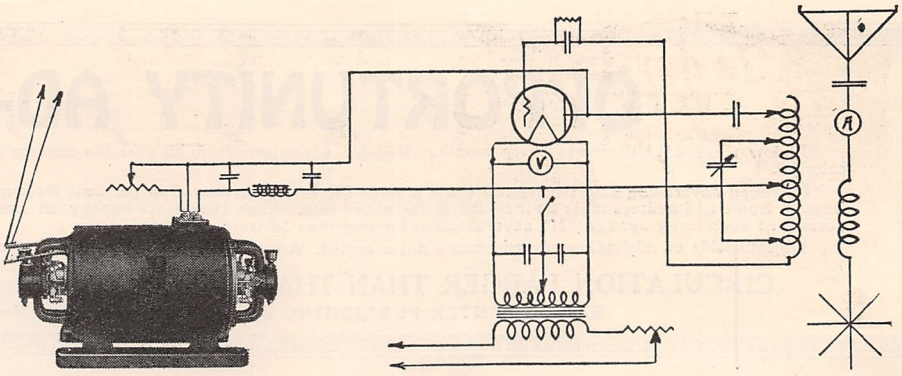
Schedule of Frequencies in Kilocycles

(Approximate wave-lengths in meters in parentheses.)

Time*	April 20	May 5	May 20	June 5	June 21
10:00 to	125	300	550	1500	3000
10:08 p. m.	(2400)	(1000)	(545)	(200)	(100)
10:12 to	133	315	630	1650	3300
10:20 p. m.	(2254)	(952)	(476)	(182)	(91)
10:24 to	143	345	730	1800	3600
10:32 p. m.	(2097)	(869)	(411)	(167)	(83)
10:36 to	155	375	850	2000	4000
10:44 p. m.	(1934)	(800)	(353)	(150)	(75)
10:48 to	166.5	425	980	2200	4400
10:56 p. m.	(1800)	(705)	(306)	(136)	(68)
11:00 to	205	500	1130	2450	4900
11:08 p. m.	(1463)	(600)	(265)	(122)	(61)
11:12 to	260	600	1300	2700	5400
11:20 p. m.	(1153)	(500)	(231)	(111)	(55)
11:24 to	315	666	1500	3000	6000
11:32 p. m.	(952)	(450)	(200)	(100)	(50)

*Eastern standard time for WWV, Washington, D. C.; Pacific standard time for 6XBM, California.

Being the owner of a super-selective receiver, which the slightest jar detunes, Mr. Jones conceives the idea of equipping everything and everybody with springs.



Item 11A, Type MG-343S output 1000 volts, 300 watts, an efficient and compact Power Supply for one or two 50 watters. This machine is built ruggedly yet designed to take a minimum of space. It is a machine that not only will stand the kicks of hard usage but will also give your Station a kick that will turn the Q. R. Z.'s into Q. S. A.'s.

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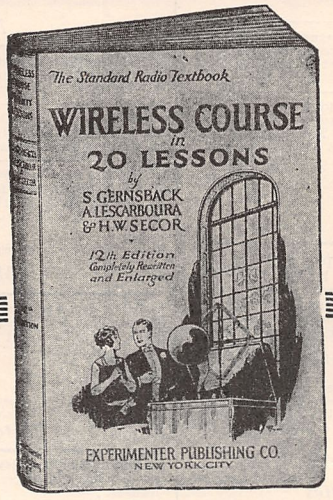
The Southern Toy Company, Inc.

Dept. N Hickory, North Carolina

Price



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References: Life Savers, Inc., Port Chester, N. Y.; Stephen F. Whitman & Son, Philadelphia; Pacific Coast Biscuit Co., Seattle, Wash.; Loft, Inc., New York City; Sprague Warner & Co., Chicago; The Warren Co., Atlanta, Ga.; K. Baldwin Co., New Orleans, La.; Joseph Burnett Co., Boston.

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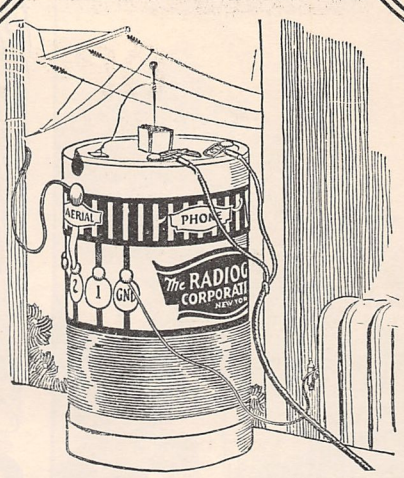

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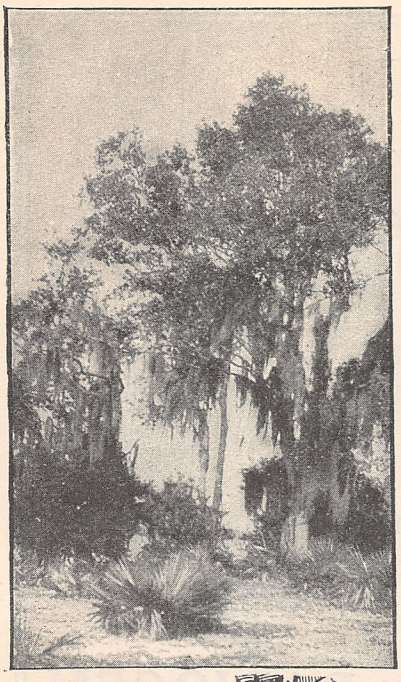

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Villa Tasso is in the Florida National Forest on the bluffs of beautiful Choctawhatchee Bay, 50 miles east of Pensacola. It is easily reached either by steamer or by motor, being adjacent to the Appalachian Scenic Highway, Old Spanish Trail and the Gulf Resorts Loop. It is high, dry and healthful. The water is sweet, pure and soft. Only 3½ miles from the Gulf of Mexico, it is still well sheltered from any possible storms. Delightful bathing beach. Game abounds in the Forest.

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SPECIAL OFFER: To secure as much development as possible this spring, a special rebate of 20% is offered to every purchaser who begins his home before June 1st, 1926. Details on request.

T. V. ORR
VILLA TASSO,
(Temporary P. O. Bolton)
FLORIDA

Scene on the bluffs at Villa Tasso. Note the man below for height

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Willard Radio Batteries are being advertised more extensively than ever.

Have your local Willard Service Station show you this advertising and explain the details of this practical plan for selling radio storage batteries. The advertisements are signed:

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Appropriate signs and window cards will identify you as an Authorized Dealer. Booklets and other valuable selling helps are also furnished.

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The new Trinity Models are ready!

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Factory Dealer Franchises will be granted in the order of their application. New dealers will be chosen with the greatest care. We suggest that they write or wire immediately!!

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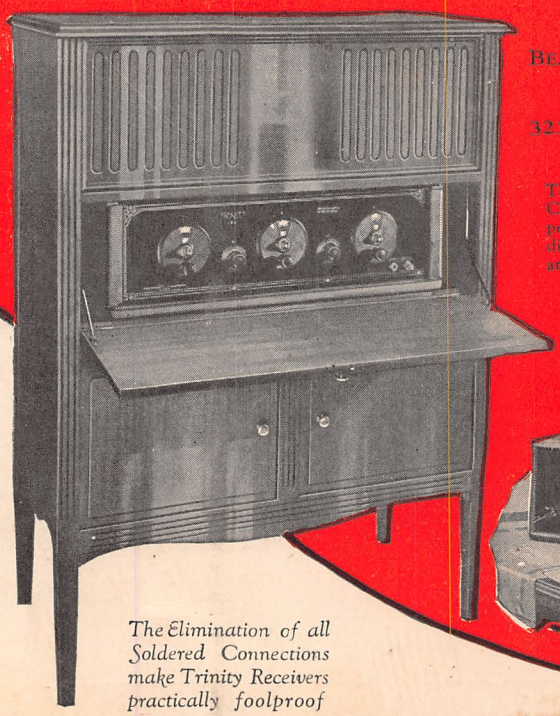

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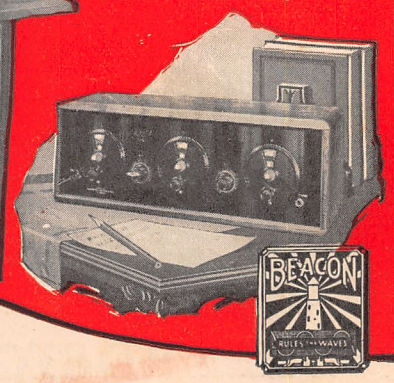

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